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Motors Liquidation Company

Investigation Work Plan

Former Building 9, Delphi-Flint West Facility
Flint, Michigan

December 30, 2010

TechLaw

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March 16, 2011

Mr. Allen Wojtas
Contract Level Contracting Officer's Representative
U.S. EPA Region 5, LP-9J
77 W. Jackson Boulevard
Chicago, IL 60604

Reference: EPA Contract No. EP-W-07-074; Task Order No. R05036; Technical Review of Motors Liquidation Company (MLC); Investigation Work Plan, Field Sampling Plan and Quality Assurance Project Plan for Former Building 9, Delphi-Flint West Facility, Flint, Michigan all dated December 30, 2010; Task 03 Deliverable

Dear Mr. Wojtas:

Please find enclosed TechLaw's Technical Review of Motors Liquidation Company (MLC) Investigation Work Plan (Work Plan), Field Sampling Plan (FSP), and Quality Assurance Project Plan (QAPP) for the Former Building 9, Delphi-Flint West Facility, Flint, Michigan all dated December 30, 2010. For your convenience, this deliverable was also E-mailed directly to you in MS Word format.

Several general and specific comments regarding the Work Plan, FSP, and QAPP are included in the attached document. Specifically, the Work Plan does not contain adequate discussion justifying the selection of the number and locations of soil borings and groundwater monitoring wells.

In addition, TechLaw reviewed the QAPP against the *EPA Requirements for QA Project Plans* (QA/R-5), dated May 2001 and the *Guidance for Quality Assurance Project Plans* (QA/G-5). It should be noted that the QAPP does not follow the exact format shown in that QA/R-5 (e.g., A1, A2, etc.). However, since the QAPP appeared to address the majority of the QA/R-5 elements, no comments were made on the format. TechLaw found that the QAPP is lacking many of the requirements as specified by QA/R-5, which are discussed in the following comments.

If you have any questions or wish to discuss these issues further, please contact Mr. Bradley Martin, who can be reached at (312) 345-8960.

Sincerely,

Terry Zdon

Terry Zdon
Program Manager

cc: C. Kerzher, EPA CO (E-mail only)
C. Black, EPA TC
B. Martin, TechLaw (E-mail only)
B. Smith (E-mail only)
Chicago Central Files

TECHNICAL REVIEW OF THE MOTORS LIQUIDATION COMPANY (MLC) INVESTIGATION WORK PLAN, MLC FIELD SAMPLING PLAN AND MLC QUALITY ASSURANCE PROJECT PLAN

FORMER BUILDING 9
DELPHI-FLINT WEST FACILITY
FLINT, MICHIGAN
DECEMBER 30, 2010

Submitted to:

Mr. Allen Wojtas
Contract Level Contracting Officer's Representative
U.S. Environmental Protection Agency
Region 5, LP-9J
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Chicago, Illinois 60604

Submitted by:

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March 16, 2011

**TECHNICAL REVIEW OF
THE MOTORS LIQUIDATION COMPANY (MLC)
INVESTIGATION WORK PLAN, MLC FIELD SAMPLING PLAN AND
MLC QUALITY ASSURANCE PROJECT PLAN**

**FORMER BUILDING 9
DELPHI-FLINT WEST FACILITY
FLINT, MICHIGAN
DECEMBER 30, 2010**

Soil Borings AOC I

MLC INVESTIGATION WORK PLAN COMMENTS

GENERAL COMMENTS

What are the units sampled? Geologic

1. Based upon the historical analytical results presented in the Motors Liquidation Company (MLC) Investigation Work Plan (Work Plan) for the Former Building 9, Delphi-Flint West Facility, Flint, Michigan all dated December 30, 2010, it is noted that additional exceedances outside of the areas of concern (AOCs) are recorded in Appendix A. The areas of concern are focused on the north and west portion of the property; however, historical exceedances were recorded in the middle and eastern portions of the property. For example, historical samples SB-TW-P9-4-2, SB-TW-P9-4-1, and SP-14 had historical exceedances which should be updated with additional analytical data. Revise the Work Plan to discuss the reasoning for no further investigation in these areas in the text.

   Down gradient of the Same/NW/S. Park. lot.

2. Historically, limited sampling has taken place in AOC-1 and only two soil boring/monitoring well locations are planned within this area. In order to evaluate the area based on confirmation samples, additional sampling appears necessary to delineate the area around the former chrome plater and completely define the nature and extent of contamination. Revise the Work Plan to include additional samples in the southern portion of AOC-1, where no historical sampling has been performed, and in the eastern portion, where historical sample results indicated exceedances.

SPECIFIC COMMENTS

1. **Section 3.3, Gravel Area, Northwest Side of Building 9 (AOC-2B), Page 10:** This section states "The location of AOC-2B is shown on Figure 2." Revise this section to reference Figure 3, Existing Conditions Map, which depicts the location of AOC-2B.

2. **Section 3.3, Gravel Area, Northwest Side of Building 9 (AOC-2B), Page 10:** This section contains a table that presents groundwater monitoring results. The table does not contain any historical sample numbers to allow comparison of the results with sample locations. Revise this section to include historical sample numbers in the table.

3. **Section 4, Data Gaps, Off-Site Contaminant Migration, Page 12:** According to Section 4, Data Gaps, "The investigation will delineate the VOC [Volatile Organic

Compound] plume and assess the degree to which VOC concentrations may have attenuated." Based upon the limited sampling which is described in the Work Plan, the lack of sampling located off-site, and the age of historical data, it may not be possible to delineate the VOC plume based upon the data obtained during this investigation. Revise the section to incorporate future sampling efforts and offsite sampling which may be necessary to delineate the VOC plume.

4. **Section 5.1.3.2, Soil Quantity Delineation Locations, Page 14, and Section 5.1.3.3, Groundwater Quantity Delineation Locations, Page 15:** These sections discuss the proposed soil boring and groundwater monitoring well locations that are presented on Figure 4, Proposed Subsurface Investigation Boundaries. It is unclear how the number and locations of soil borings and groundwater monitoring wells selected will define the nature and extent of contamination at all AOCs. For example, only one soil boring and one groundwater monitoring well are proposed for AOC-1. Please revise these sections to include a discussion that justifies the selection of the number and locations of soil borings and groundwater monitoring wells with respect to delineating the nature and extent of contamination at all AOCs.

5. **Section 5.2.3, Groundwater Monitoring Well Installation, Page 16:** This section discusses installation of groundwater monitoring wells, but does not identify or discuss the depth and length of the screened interval of the wells. Revise this section to discuss the depth and length of the screened interval of the wells.

6. **Section 5.2.4, Soil and Groundwater Sampling, Page 16:** This section discusses soil sampling and indicates that soil samples will be collected from zero to six inches below ground surface (bgs). It is unclear why soil sampling will only be conducted to a depth of six inches. Revise this section to justify this approach in light of defining the nature and extent of contamination.

7. **Table 1, Historical Soil Sample Results – Detected Constituents, and Table 2, Historical Groundwater Sample Results – Detected Constituents:** Table 1 and 2 include historical soil and groundwater maximum detected concentrations, but do not contain the historical sample numbers associated with the maximum detected concentrations to allow comparison with the data contained in Appendix A, Historical Analytical Data Figures, and Appendix B, Historical Analytical Data. Revise Table 1 and 2 to include the historical sample numbers associated with the maximum concentrations of constituents detected.

8. **Figure 2, Surrounding Land Use Map:** In this figure, the "Approximate Site Property Line" is not clear based on the legend. Revise the figure to show the "Approximate Site Property Line" more distinctly such as a different color.

9. **Figure 3, Existing Conditions Map:** Not all symbols on the figure are defined in the Legend. For example, the red boxes shown on the figure near AOC-2B, the green symbols assumed to be trees and shrubbery, and the line with "X"s assumed to be a fence line, are not defined in the Legend. Revise the Legend to include all symbols used in the figure. Also, indentify which of the completed monitoring wells have been located for

the upcoming work and are anticipated to be sampled by changing the color of those wells.

10. **Figure 4, Proposed Subsurface Investigation Boundaries:** Not all symbols on the figure are defined in the Legend. For example, only one symbol is shown in black, which is the completed monitoring well location (a circle with a plus sign in it). Other black symbols appear on the figure including a black dot, and a circle with a plus sign superimposed on it (similar to the proposed soil boring location symbol in red). Revise the figure legend to include all symbols used on the figure. Also, indentify which of the completed monitoring wells have been located for the upcoming work and are anticipated to be sampled by changing the color of those wells.

11. **Appendix A, Historical Analytical Figures:** Appendix A does not include historical analytical results for all of the sample locations indicated in the figures. For example, the historical analytical results for sample points SP-01 through SP-05 in the former chrome plater and former TCE degreaser locations are not presented in the figures. Revise Appendix A to include the historical analytical results for all of the soil and groundwater sampling locations presented in the figures.

MLC FIELD SAMPLING PLAN COMMENTS

SPECIFIC COMMENTS

1. **Section 2.5, Monitoring Well Installation Procedures, Page 6:** This section indicates that depending on the thickness of permeable layers, the monitoring well screen length may be reduced to five feet, but does not discuss how this decision was made. Revise this section to discuss the logic behind reducing the screen length to five feet.

2. **Figure 1, Existing Conditions Map:** Not all symbols on the figure are defined in the Legend. For example, the red boxes shown on the figure near AOC-2B, the green symbols assumed to be trees and shrubbery, and the line with "X"s assumed to be a fence line, is not defined in the Legend. Revise the Legend to include all symbols used in the figure. Also, indentify which of the completed monitoring wells have been located for the upcoming work and are anticipated to be sampled by changing the color of those wells.

3. **Appendix A, Soil Drilling and Sample Collection:** Section 2.3, Soil Boring and Sampling Procedures, of the FSP states that "The borings will be abandoned after sampling in accordance with the QAPP [Quality Assurance Project Plan] and ARCADIS SOP [Standard Operating Procedure] for Soil Drilling and Sample Collection in Appendix A." This section of Appendix A does not address well abandonment. Revise Appendix A, Soil Drilling and Sample Collection, to address well abandonment as referenced in Section 2.3.

<u>**MLC QUALITY ASSURANCE PROJECT PLAN COMMENTS**</u>

GENERAL COMMENTS

1. The Motor Liquidation Company, Quality Assurance Project Plan, Former Building 9, Delphi-Flint West Facility, Flint Michigan, (QAPP) dated December 2010, often references the Work Plan for information required by the *EPA Requirements for QA Project Plans* (QA/R-5), dated May 2001. However, the QAPP does not provide specific references to where the information can be found in the Work Plan. Revise the QAPP to provide specific section, subsection and page references to the Work Plan when needed.

2. The data quality objectives (DQOs) presented in Table 1 are insufficiently detailed. For example, the decision rule column states that additional monitoring wells may need to be installed depending on the groundwater flow, the presence of light non-aqueous phase liquids (LNAPL), and level of hazardous constituents above the Michigan Part 201 generic clean up criteria. However, it is unclear why the decision rules for the Groundwater LNAPL Monitoring and the Groundwater Chemical Sampling only discuss exceedances at the edge of the monitoring network, as this does not appear consistent with the problem statements. Further, the QAPP does not discuss the decision rule for vertical migration which is discussed in the first problem statement. Revise the QAPP to provide detailed DQOs consistent with the *Guidance on Systematic Planning using the Data Quality Objectives Process* (QA/G-4), dated February 2006.

3. The QAPP references the Work Plan for the sampling rationale. However, the rationale provide in Table 3 of the Work Plan is insufficiently detailed. For example, the table does not provide the rationale behind the number and type of samples to be collected, including why the proposed number and type are sufficient to meet DQOs. Revise the QAPP to provide a detailed sampling rationale for all proposed matrices.

4. The QAPP does not provide an approval sheet. Revise the QAPP to provide an approval sheet that includes the title of the plan, the name of the organization(s) implementing the project, the effective date of the plan, and the names, titles, signatures, and approval dates of appropriate approving officials as specified in Section 3.2.1 of QA/R-5.

5. The QAPP does not provide a distribution list. Revise the QAPP to list the individuals and organizations that need copies of the approved QAPP, and any associated revisions, as specified in Section 3.2.3 of QA/R-5.

6. The QAPP does not provide an organizational chart of all project personnel. Revise the QAPP to provide an organization chart as described in Section 3.2.4 of QA/R-5.

7. The QAPP states that contaminants of concern (COCs) include VOCs, semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and metals. However, the no rationale has been provided to support the specific analyte lists in Table 3. Revise the QAPP to provide the rationale behind the specific analytes listed in Table 3.

8. The QAPP does not provide sufficient historical and regulatory background information on the site. As specified in Section 3.2.5 of QA/R-5, revise the QAPP to provide this information or reference where this information can be found.

9. The QAPP does not include a list of the products to be produced or maps/tables that show the locations of field tasks. Revise the QAPP to provide this information as per Section 3.2.6 of QA/R-5.

10. The QAPP does not provide the level of information required by Section 3.2.9 of QA/R-5. For example, the QAPP does not describe the process for ensuring project personnel have the most current version the QAPP. The QAPP also does not provide an itemized list of the information and records to be included the data report package or provide a list of any additional records or documents that will be produced. Revise the QAPP to provide the information specified by Section 3.2.9 of QA/R-5.

11. Section 3.3.2 of QA/R-5 states that if a sampling method allows for the user to select from various options, then the QAPP should specify which options are proposed. However, while the field SOPs discuss multiple options for collecting samples, the QAPP does not indicate which are proposed for use. Revise the QAPP to specify which soil sampling procedures will be used.

12. The QAPP does not provide sub-sampling, extraction and/or cleanup methods as discussed in Section 3.3.4 of QA/R-5. Revise the QAPP to provide this information.

13. The QAPP does not identify the QC activities needed for each analytic/measurement technique (i.e., for field and laboratory procedures) as discussed in Section 3.3.5 of QA/R-5. Revise the QAPP to provide this information.

14. The QAPP does not provide sufficient detail on the calibration, inspection, and maintenance of laboratory and field instruments and equipment. The QAPP should contain the level of detail as described in Section 3.3.6 of QA/R-5. For example, the section should provide specific details on how the laboratory and field instruments and equipment are inspected and maintained. Revise the QAPP to provide this information.

15. The QAPP does not provide the level of detail required by Sections 3.3.8 and 3.3.9 of QA/R-5. For example, the QAPP does specify who will inspect and approve of consumables and supplies or what types of non-direct measurements are needed for the project. Revise the QAPP to provide the information required by Section 3.3.8 and 3.3.9 of QA/R-5

16. The QAPP specifies the field quality control samples to be collected in Section 12.2 and Table 2. However, the QAPP does not specify the measurement performance criteria which the field samples be evaluated against. Revise the QAPP to provide the measurement performance criteria that will be used.

17. A table has not been included detailing the laboratory specific reporting limits (RLs) and method detection limits (MDLs). Additionally, a table has not been included

summarizing the Michigan Part 201 cleanup criteria to be used. Without this information it cannot be easily determined if the laboratory will be able to meet the target detection limits (TDLs) and the cleanup criteria. Revise the QAPP to provide a table summarizing the screening criteria, laboratory MDLs, and RLs.

18. The QAPP does not contain examples of all forms and checklists to be used in this project (e.g., data validation checklists, samples labels, sample custody logs). Revise the QAPP to include examples of all checklists and forms to be used.

19. The QAPP states that Method 6020 will be used for metals analysis. However, Method 6020A should be used. Alternatively, if Method 6020 will be used ensure that a post digest spike is run if the matrix spike/matrix spike duplicate exceeds acceptance limits. Additionally, ensure that the quality control acceptance limits for Method 6020A are used.

20. The QAPP does not specify how total PCBs are calculated (e.g., how non-detected Aroclor results are handled when calculating total PCBs). Revise the QAPP to specify how total PCB results are calculated.

21. The QAPP does not present sufficient detail on how soils for VOCs will be collected. For example, neither Table 3 nor the soil sampling SOP includes the VOC soil sample volume or volume of methanol needed to preserve the samples. Further, the QAPP does not discuss the use of preweighed vials, how/where methanol will be added, or if weighing of vials in the field will occur. Revise the QAPP to provide this information.

SPECIFIC COMMENTS

1. **Section 2.1, Project Organization, Page 4:** The Project Organization Table does not include the name of the laboratory QA manager. Revise the table to include the name of the laboratory QA Manager.

2. **Section 5. Quality Objectives and Criteria for Measurement Data, Page 15:** This section states that the DQOs for the investigation activities will be refined upon development of the investigation work plan, and, if required, the QAPP will be modified. However, it appears that the Work Plan is already developed. Revise the QAPP to clarify this.

3. **Section 7.5.2, Laboratory Data Reporting, Page 23:** This section states that the laboratory is responsible for preparing full CLP-equivalent (Level 3) data packages for all laboratory analysis. However, the QAPP does not specify what consists of a Level 3 data package. Revise the section to provide an itemized list of what will be included in the data packages.

4. **Section 9.2, Soil Sampling, Page 27:** This section is insufficiently detailed. The section states that additional samples may be collected if impacted soil is encountered based on high photo ionization detector (PID) readings and visual observations. This section

further states that if there is no evidence of impacted soil throughout the sample, an additional sample may be collected from the interval above the water table if deemed necessary. However, it is unclear what is considered a high PID reading, or what criteria will be used to determine if additional samples will be collected (e.g., soil staining, a PID reading above a certain level, etc.). Revise the QAPP to clarify when additional samples will be collected and what is considered a high PID reading.

5. **Section 12.6, Data Completeness Assessment Procedures, Page 42:** This section states that the overall project completeness is expected to be at least 90%. However, a specific goal for both laboratory and field completeness should be provided. Revise the QAPP to provide both a field and laboratory completeness goal. Further, revise the QAPP to briefly discuss why the proposed completeness goals are sufficient.

6. **Section 16, Data Management, Page 49:** The data management discussion is insufficiently detailed. For example, it is unclear how data validation flags are entered into the database and verified. Revise the section to provide further details on the data management process and ensure all items discussed in Section 3.3.10 of QA/R-5 are included.

7. **Section 16.4.6, Document Control and Inventory (Archiving, Storage and Retrieval), Page 54:** This section states that documents, reports, records, and data will be retained for future reference and hardcopy formats of project documents will be maintained in ARCADIS' project files. However, this section does not indicate how long project files will be stored and does not provide the specific location (i.e., address) where files will be stored. Revise this section to provide this information.

8. **Section 17.2, External Field Performance and System Audit Procedures, page 55:** This section states that there will only be external field performance and system audits. However, the section also states the Task Managers will monitor field performance, which appears to be an internal assessment. Revise this section to clarify this discrepancy and to include internal audits by ARCADIS if they will be performed. If no internal audits/assessments will be performed, ensure that the QAPP discusses why this is sufficient. Finally, ensure that the level of detail as discussed in Section 3.4.1 of QA/R-5 is included in this section.

9. **Section 17.3, Laboratory Audits, page 56:** This section indicates that only external audits by EPA will occur. However, it is unclear why ARCADIS does not audit the selected laboratory. Revise this section to clarify this.

10. **Section 18, Reports to Management, Page 59:** The information presented in this section is insufficiently detailed. For example, this section does not identify the frequency and distribution of reports issued to inform management of the project status. Revise the section to provide the level of detail discussed in Section 3.4.2 of QA/R-5.

11. **Section 20, Data Validation and Verification, Page 63:** This section states that a designated data validator will validate all analytical data using the versions of USEPA's Function Guidelines (USEPA, 1999) and USEPA Region Innovative Approaches to Data

Validation, USEPA Region II (June 1995). However, the EPA Functional Guidelines are only directly applicable to Contract Laboratory Program (CLP) methods. Clarify if these validation procedures will be modified for SW-846 methods. If so, clarify how the validation procedures will be modified. Additionally, this section does not specify if a third party data validator will be used. Revise the QAPP to clarify this.

12. **Section 20, Data Validation and Verification, Page 63:** This section states that the data review (Tier II) utilizing M-2 (organic) and IM-1 (inorganic) will be performed on 100% of the laboratory QC summary data deliverables. However, it is unclear what consists of M-2 and IM-1 data review. Revise the QAPP to provide further detail on M-2 and IM-1 data review.

13. **Section 20, Data Validation and Verification, Page 64:** This section does not describe how results will reconciled with the user/decision maker requirements. Revise the section to provide the level of detail as specified in Section 3.5.3 of QA/R-5.

14. **Table 4 – Analytical Quality Control Limits:** Footnote 1 of this Table states that the listed quality control (QC) limits are based on SW-846 advisory and the actual limits are determined based on laboratory performance. However, the laboratory specific QC limits have not been provided. Revise this table to provide the laboratory specific QC control limits.

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Copies:
Dave Favero, MLC (email only)

From:
Chris Peters

Date:
January 6, 2010

Subject:
QAPP, FSP & WP

ARCADIS Project No.:
B0064605.2010

We are sending you:

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2 hardcopies				Field Sampling Plan Former Building 9, Delphi-Flint West Facility, Flint, Michigan	
2 hardcopies				Investigation Work Plan Former Building 9, Delphi-Flint West Facility, Flint, Michigan	

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Comments: ______

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Christopher S. Peters, PG
Project Manager

Investigation Work Plan

Former Building 9, Delphi-Flint West Facility
Flint, Michigan

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Our Ref.:
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Date:
December 30, 2010

ARCADIS

Tables

Figures

Appendices

1. Introduction

As of July 10, 2009, as a result of General Motors Corporation's (GMC) bankruptcy, GMC was renamed Motors Liquidation Company (MLC). On the same day some of the operating assets of GMC were sold to a newly formed company, "General Motors Company". General Motors Company changed its name to General Motors LLC (GM LLC) on October 16, 2009. Assets not sold to GM LLC remain the property of MLC, in its capacity as a debtor-in-possession in the bankruptcy case.

This Work Plan for the MLC former Building 9, Delphi-Flint West Facility (herein referred to as the Site), has been prepared for review and approval by the US Environmental Protection Agency (USEPA).

1.1 Site Description

The Site is located at the corner of Stevenson Street and Glenwood Avenue in Section 12, Township 7 North, Range 6 East, Flint, Genesee County, Michigan (see **Figure 1**). The former building at the Site was approximately 80,897 square feet in size before its demolition in 1996, and was part of a series of approximately 40 buildings (most of which have been demolished) within the Flint West complex. **Figure 2** shows the property boundaries and provides a layout of the surrounding land use. The Site is owned by MLC and partially leased by Asylum Substation, which is owned by Consumers Energy.

1.2 Former Site Operations

The facility use and operation descriptions were taken from the following reports:

- *Phase I Environmental Site Investigation Report, Building 9, Delphi-Flint-West Facility, Flint, Michigan.* (1997 Phase I ESA). Prepared by Blasland, Bouck & Lee, Inc. (BBL). June 1997 (BBL, 1997a)

- *Phase II Environmental Site Investigation Report, Building 9, Delphi-Flint-West Facility, Flint, Michigan.* (Phase II Investigation), prepared by BBL. June 1997. (BBL, 1997b).

- Supplemental *Phase II Environmental Site Investigation Report, Building 9, Delphi-Flint-West Facility, Flint, Michigan.* (Supplemental Phase II Investigation), prepared by BBL. February 1998. (BBL, 1998a)

- *Baseline Environmental Site Assessment Former Building 9 (Asylum Substation), Delphi- Flint West Facility, Flint, Michigan.* (BEA), prepared by BBL. September 1998. (BBL, 1998b).

Prior to construction of the former Building 9 at the Site in 1929, the Site was a residential area. Former Building 9 was originally used as a mechanic shop and was eventually converted into an assembly line manufacturing plant that produced intake and exhaust engine valves. Processes that have been conducted at Building 9 include: forging, plating, degreasing/parts cleaning, process wastewater collection and transport, lubrication, grinding/forming, welding, forming, heat treating and recycling, soluble lubricating oils treatment and recycling, and tumbling. These processes had potential to release contaminants into the environment. Since its initial construction, additional construction activities occurred twice at Building 9; the first was an addition in 1971 and the second was the construction of an overhead roof that was added to the north storage area in 1986. The building underwent decommissioning and demolition activities in 1996. At the time of demolition, all machinery and wooden floor blocks were removed, trenches and sumps were cleaned, filled, and capped with concrete, and hazardous and non-hazardous materials were containerized for disposal or recycling.

1.3 Surrounding Land Use

The Site is bordered by former industrial automotive manufacturing facilities to the north and west (sometimes referred to as the Chevy-in-the-Hole property, now owned by the City of Flint). Previously, there had been railroad tracks along the north-north western side of the Site between Building 9 and the Chevy-in-the-Hole property. The current property owner of the former railroad tracks is unknown at this time; however, investigations are ongoing by ARCADIS and MLC to determine ownership. To the east of the Site is Stevenson Street and directly south is a parking lot. The Flint River is located approximately 1/10th of a mile to the north-northwest of the Site. The Flint River is controlled and contained within a concrete channel constructed in 1966 and 1967 by the United States Army Corp of Engineers (USACE). The channel consists of concrete on the sides and bottom. Property ownership of the Site and surrounding parcels is shown on **Figure 2**.

1.4 Previous Investigations

Several environmental investigations have been conducted at the Site since 1993 to delineate the impacts from previous on-site releases. These investigations are described below.

BBL submitted six reports pertaining to Building 9 between 1993 and 1998, including two Phase I Environmental Site Assessment Reports (June 1993 and June 1994), an Environmental Compliance Audit (January 1995), a Phase 1 Environmental Site Assessment (ESA) (June 1997), a Phase II Environmental Site Investigation Report (June 1997), and a Supplemental Phase II Environmental Site Investigation (February 1998). Soil and groundwater concentrations were used to determine three potential areas of concern (PAOCs) including the Gravel Area - Northwest Side of the Building, the Fire Protection Trench Excavation Area, and the Former Trichloroethene (TCE) Degreasing Unit and Sump. Historical soil sample analytical results can be found in **Table 1** and historical groundwater sample analytical results can be found in **Table 2**.

1.5 Notice of Off-Site Migration

Based on previous investigations, off-site migration of impacted groundwater related to on-site releases could be inferred based on contaminant concentrations at or near the property boundary. In accordance with Part 201 of Public Act 451 of the State of Michigan Natural Resources and Environmental Protection Act (Part 201), if soil or groundwater concentrations in excess of Part 201 cleanup criteria are observed or can be assumed to be present on a property other than the source property, notification is required to be submitted to the property owner and the Michigan Department of Natural Resources and the Environment (MDNRE). A notification was sent to the MDNRE on November 22, 2010, but the current owner of the property directly north-northwest of Building 9 (decommissioned railroad tracks) is unknown. Once the correct property owner(s) have been identified, the form, or similar type of correspondence, will be used to notify the potentially affected property owners.

So beyond "unknown" property? onto anything else?

1.6 Work Plan Approach and Objectives

This Work Plan has been prepared to provide present the investigation plan for the Site needed to fill the data gaps in order to define the nature and extent of contamination on and in the vicinity of the Site. The sampling locations proposed in this Work Plan are designed to define the impact of contamination from previous Site releases, so that appropriate response activities can be implemented. These response activities could include risk-based closure (deed restrictions) and monitoring, active soil and/or groundwater remediation, or a combination of these responses.

2. Site Setting

2.1 Geology and Hydrogeology

2.1.1 Regional

Pleistocene glacial drift overlays Paleozoic sedimentary rocks in the Flint area (Wiitala et al., 1963). Pre-Cambrian igneous and metamorphic rocks of the Canadian Shield form the bedrock upon which several thousand feet of sandstone, limestone, shale, and evaporates of the Michigan Basin have been deposited. The Flint area is located in the southeast portion of the basin.

Glacial drift of generally low hydraulic conductivity mantles the bedrock in nearly all parts of Genesee County. These deposits consist of clay, silty sand, gravel, and boulders. Hydraulic conductivity is highly variable in both the horizontal and vertical planes. Glacial deposits, in general, are an important source of water in Michigan. However, outwash plains and buried stream valleys are the most productive facies. The lacustrine deposits that are predominant in the vicinity of Flint have low permeabilities due to the abundance of clay (Wiitala et al., 1963). Thin lenses of permeable sand and gravel yield adequate water for domestic use, but the primary source of groundwater in communities surrounding the Flint area is the Pennsylvanian Saginaw bedrock aquifer (Wiitala et al., 1963). The City of Flint itself purchases water from the City of Detroit, who obtains water from Lake Huron. The glacial deposits are approximately 50 feet thick in the vicinity of Flint.

In the vicinity of Flint, sandstones of the Pennsylvanian Grand River and Saginaw formations form the uppermost bedrock aquifer. The top of the Saginaw formation lies between 600 and 700 feet msl. The property is approximately 756 feet above msl. Fractures greatly enhance the permeability of the sandstone beds.

Shale, siltstone, and thin-bedded sandstone intercalated with shale of the lower Saginaw Formation serve as a regional confining unit separating the Grand River-Saginaw aquifer from the Parma-Bayport aquifer (Wiitala et al., 1963). The Late Mississippian Bayport Limestone and the Early Pennsylvanian Parma Sandstone Member of the Saginaw Formation make up the Parma-Bayport aquifer. The Parma-Bayport aquifer is not used as a source of water in the vicinity of Flint.

The Mississippian Michigan Formation lies beneath the Saginaw Formation. The upper portion is composed of shale, thin-bedded limestone, dolomite, gypsum, and anhydrite, and separates the Parma-Bayport aquifer from the Marshall aquifer. Sandstones in the lower portion are hydraulically connected to the Early Mississippian Marshall Sandstone below and compose the Marshall aquifer. The thickness of the Michigan Formation averages around 100 feet in the vicinity of Flint (Wiitala et al., 1963).

The Marshall Formation is present in most of Genesee County. It consists primarily of sandstone, with some beds of conglomerate, shale, and dolomite. Thickness varies from over 200 feet in the northern part of the county to 70 feet in the south. In some places, the Marshall, Michigan, and Saginaw formations from a single aquifer (Wiitala et al., 1963).

The early Mississippian Coldwater Shale forms the base of the aquifer system and ranges in thickness from 500 to 1,100 feet.

2.1.2 Site Specific

The geology beneath the Site was characterized from materials collected during the installation of soil borings and monitoring wells completed as part of the reports listed in Section 1.2. Sands, silty sands, and clayey sands were present beneath a layer of fill that included coal and metal shavings. The native clay and till in the Flint vicinity are not useable aquifers and according to the Genesee County Health Department, there have been no potable water wells drilled to tap the glacial drift at least since 1967, when records were first required. In addition, Michigan Department of Public Health regulations require potable wells to be cased to a minimum of 25 ft below ground surface (bgs) (Rule 818). Personnel from the City of Flint Water Services state that hookup to City water is mandatory within City Limits.

No groundwater contour maps were prepared during the previous investigations at the Site. However, based on an understanding of the local hydrogeology, groundwater elevations are believed to be relatively shallow (10 feet bgs or less). Based on the location of the Site, the predominant direction of groundwater flow is to the north-northwest, toward the Flint River, which is the major groundwater discharge point in the area. However, the presence of Swartz Creek to the east and southeast of the Site suggests that there may be a groundwater divide near the Site, with groundwater flowing both southeast and northwest from the divide.

2.2 Site Hydrology

Located approximately 1/10th of a mile north of the property, the Flint River is controlled and contained within a concrete trench that was constructed in 1966 and 1967 by the USACE. The river generally flows to the west-northwest. The property is approximately 756 feet above mean sea level. Swartz Creek lies to the east and south (approximately 800 feet) of the Site and is a tributary to the Flint River. Swartz Creek generally flows to the north and flows into the Flint River approximately 1200 feet northeast of the Site. Historically, storm water runoff was collected in catch basins from the parking areas and roof drains and was transferred by storm sewer lines through storm water outfalls to the Flint River.

3. Areas of Concern

The approximate locations of Areas of Concern (AOC) on the Site are shown on **Figure 3** and are discussed in more detail below. The selection of these areas as AOCs was based on a review of historical information and previous soil and groundwater samples collected at the Site.

3.1 Former Chrome Plating Area (AOC-1)

A chrome plating operation (herein referred to as AOC-1) was conducted in the building from 1982 to 1991 (see **Figure 3**). The Michigan Department of Natural Resources (MDNR) uniform hazardous manifests obtained by BBL during the Phase I ESA (BBL, 1997), indicates that approximately 3,000 gallons of reportable quantity hazardous chromic acid waste, ORM-ENA9189 (EPA D007) were transported off-site each week. A records file search completed by BBL revealed that the chrome plating system was decontaminated by scrapping and pressure washing. Dismantling the chrome plating area took 19 months to complete (from March 20, 1990 to October 13, 1991). Equipment and debris were placed in roll-off containers, while decontamination liquids and process wastes from the sumps were placed in drums and transferred off-site. Although personnel familiar with the Site indicated that the sumps appeared competent at the time of decontamination, there was no clean closure verification performed at this area.

A discharge related to chrome plating operations was reported on June 15, 1990, and approximately 1 pound of chromic acid waste leaked from a gondola onto the pavement and into a storm sewer catch basin. During a previous investigation, soil and groundwater samples collected downgradient and upgradient of the spill indicated that some quantity did overflow the basin. A limited investigation that followed the cleanup did not detect chromium in soils at the outflow point. Because there is no clean closure verification and only a limited investigation after the reported spill, the former chrome plating area is classified as an area of concern (AOC). Historical soil and groundwater concentrations from previous subsurface investigations can be found in **Tables 1** and **2**, respectively. Historical soil sample and groundwater sample locations and data can be found in **Appendices A** and **B**, respectively.

3.2 Former Trichloroethene Degreaser Units and Sump (AOC-2A)

TCE was used as a vapor degreasing solvent in the former degreasing area of Building 9 (see **Figure 3**), although it was not certain whether the TCE was contained in a sump or in a vat located within the sump. The sump was pumped out periodically and the waste was disposed of off-site. According to the BBL Phase I ESA (BBL, 1997), there was a documented TCE spill from the degreasing unit on June 7, 1991, which entered the wastewater treatment system. Concentrations of TCE have been detected in a downgradient monitoring well and therefore, the former TCE degreasing unit is considered an AOC (herein referred to as AOC-2A). Historical soil and groundwater concentrations from previous subsurface investigations at the Site are located in **Tables 1** and **2**, respectively. Historical soil sample and groundwater sample locations and data can be found in **Appendices A** and **B**, respectively.

3.3 Gravel Area, Northwest Side of Building 9 (AOC-2B)

During BBL Site visits in 1993, the stairs leading down to the gravel area from the northwest side of the former building were heavily stained with oils. Rainwater on the stairs exhibited a petroleum sheen. The gravel area contained areas that exhibited heavy oil stains as did as another set of stairs leading from the power room. GM excavated the top 6- to 12 inches bgs and the material was disposed offsite. Analytical results from soil and groundwater samples collected at this AOC during the Phase II investigation (BBL, 1997) indicated that semi-volatile organic compounds (VOCs and SVOCs) were not detected above appropriate regulatory cleanup criteria. However, an obvious solvent odor was observed in this area during soil boring installation. During a previous investigation, property personnel were interviewed and it was indicated that oil was probably dragged out by employee traffic.

Groundwater impacts in the Gravel Area are similar to those found at the former TCE degreasing units. As such, these two AOCs are associated and will be referenced as AOC-2A (TCE Degreasing Area) and AOC-2B (Gravel Area) for the purpose of this work plan and subsequent investigation. The location of AOC-2B is shown on Figure 2. The concentrations in groundwater reported in the Supplemental Phase II Report for the Gravel Area (BBL, 1998) are presented in the table below and compared to Michigan Part 201 Residential Drinking Water (RDW) and Groundwater –Surface Water Interface (GSI) cleanup criteria. Exceedances of these criteria are bolded.

Analyte	Conc. (µg/L)	Part 201 GSI Criteria (µg/L)	Part 201 RDW Criteria (µg/L)
1,1-dichloroethane	4	740	880
Cis-1,2-dichloroethene	**1,000**	620	70
Methyl-tert-butyl ether	120	730	240
Trichloroethene	**350**	200	5
Vinyl Chloride	**190**	2	2

3.4 Stormwater Pump and Sump in North Storage Area (AOC-3)

Located in the North Storage Area of Building 9 is a pump and sump system (herein referred to as AOC-3) (**Figure 3**) that was designed to collect overland runoff from the Site and pump the water to the Flint West pollution wastewater system. Previous investigations discovered that on May 14, 1993, a MDNR "report of oil, salt or polluting losses" form was filed. The form indicated that the stormwater pump in the north storage area became uncoupled and approximately 50-100 gallons of oil overflowed the trench at the northeast corner of Building 9 and flowed onto Stevenson Street. The form indicated that the oil also flowed onto the railroad tracks and ran east along the tracks (along natural drainage paths to the north and east) a distance of 75-100 feet. During a BBL walkthrough of the Site (1993), a small amount of oil was observed at the Site. The pump in the sump failed and a small amount of oil was observed flowing into Stevenson Street during the October 1995 walkthrough of the site. During another walkthrough in 1996, oil was not observed near the previously stained area; however, another release of oil and oily wastewater occurred in May 1996. Because the oil was released along the railroad tracks onto a porous (gravel) area, there exists the potential for oil to have permeated into the underlying soil and groundwater. Historical soil and groundwater concentrations from previous subsurface investigations at the Site are located in **Tables 1** and **2**, respectively. Historical soil sample and groundwater sample locations and data can be found in **Appendices A** and **B,** respectively.

On November 13, 1991, free petroleum product was observed on the pump intake pipe in an 8-inch diameter and approximately 218 ft bgs drinking water well, which had been installed at the Site in 1937. After further investigation, 11.5 ft of petroleum product was measured floating on the water in the well (depth to water unknown). The well had a steel casing to a depth of 52 ft bgs and had not been used as a drinking water source since the 1950's. The source of the product is unknown, although vandalism was suspected. The free product was pumped out of the well and the well was purged. Subsequent analysis of the well water indicated that it was below detection limits for VOCs and SVOCs. The product did not have contact with the surrounding geology because it was present in the portion of the well that had a solid casing, although the integrity of the casing was unknown. Furthermore, the documentation of oil releases described above suggests there may be a source for the oil found in the well in close proximity. Further investigation is necessary to determine the potential for light non-aqueous phase liquid (LNAPL) presence in the soil and groundwater in this area.

4. Data Gaps

Based on an evaluation of the available information, the following major data gaps exist at the Site. The investigation proposed in the following sections of this Work Plan is intended to address these data gaps.

- **Groundwater flow:** While the predominant groundwater flow direction is likely to the north-northwest toward the Flint River, the presence of Swartz Creek to the east-southeast of the Site raise the possibility that a groundwater divide is present near the Site and therefore contaminants may be migrating to the southeast in groundwater as well. Monitoring wells will be located on the Site to evaluate this possibility.

  in the same fm'n [illegible]?

- **Impacts in chrome plating area:** While it was reported by Site personnel that the chrome plating area was closed and no impacts were present, no documentation exists. Borings and monitoring wells located in the vicinity of this AOC will be completed during the investigation to verify whether the area was properly closed.

  SP, SP2, SP3 No Borings w/ Fig 4

- **Off-site contaminant migration:** While VOC impacts in groundwater were detected at the north property line and suspected to have migrated beyond the property line, the plume has not been delineated horizontally and vertically in the groundwater. Furthermore, the data are 12 years old and some natural attenuation of the plume may have occurred over that time period. The investigation will delineate the VOC plume and asses the degree to which VOC concentrations may have attenuated.

  How far offsite will you go.

- **Presence of LNAPL:** The former drinking water well discussed in Section 3.4 was found on one occasion to contain 11.5 feet of LNAPL. While no other monitoring wells in the vicinity of this well exhibited measurable thicknesses of LNAPL. LNAPL was observed in borings completed during the Phase II and Supplemental Phase II Investigations in the Stormwater Pump and North Storage Area. The historical evidence suggests that there is a source of LNAPL in this area. The investigation will evaluate LNAPL in the groundwater and soil.

  LNAPL

5. Subsurface Investigation

5.1 Proposed Investigation Activities

5.1.1 Subsurface Utility Evaluation

Known underground utilities beneath the Site include storm sewer lines, waste water lines, and process sewer lines; which are approximately 8 ft bgs. At this depth (above the water table), it is unlikely that the utility lines will act as conduits for the subsurface contamination at the Site. Additional utilities that may be at the Site would include those associated with the Asylum Substation. All utilities will be located by a utility check and visibly marked before work begins on-site. Ground penetrating radar will also be used as a line of evidence in determining utility presence underground. Finally, the top 5 feet of each soil boring location will be hand augured as a safety measure.

5.1.2 Monitoring Well Inventory

Prior to initiating the field investigation, a Site walkover was conducted to attempt to locate previously installed monitoring wells. Of the five monitoring wells that had been installed during the Phase I and II, two were located. Monitoring wells MW-P9-3-2 and MW-P9-3-3 are both identified in the same area on historical figures, however only one has been located. At the time of location the well lid was unable to be removed so there is no additional information to identify which well was located. MW-P9-4-3 was located in okay condition, however it was unable to be opened. MW-P9-5-5 was destroyed during the Asylum Substation construction. MW-P9-5-4 was not located and is believed to have been abandoned, although no documents are available to confirm this. If the two located wells are determined to be usable, they will be redeveloped using the procedures described in Section 4.2.5. Water levels will be measured at each existing well to help determine depth to the water table for future investigation purposes.

Still usable? Const (integrity)

5.1.3 Soil and Groundwater Investigation Plan

5.1.3.1 Investigation Approach

The overall purpose of the investigation is to determine the nature and extent of releases from the identified AOCs. Because of the limited amount of available soil and groundwater data on Site, the investigation will be performed in two phases. The first phase of work is described in this Work Plan. The objective of the first phase is to:

- Determine whether constituents of concern (COCs) are migrating off-Site in the groundwater from the AOCs;
- Determine the overall direction of shallow groundwater flow on-Site;
- Determine whether soil is impacted at the identified AOCs; and
- Determine whether LNAPL is present in the subsurface on-Site.

As such, the first phase of investigation as described herein will include a limited number of soil borings within the AOCs, shallow monitoring wells located at the expected downgradient edge of the property at the AOCs, and additional shallow monitoring wells located at the expected upgradient edge of the property.

A second phase of investigation will be performed based upon the results of the initial investigation phase. It is expected that the second phase will include delineation of source area impacts within each AOC, as necessary, additional downgradient groundwater monitoring wells (possibly beyond the property boundary) to delineate groundwater impacts, and potentially deeper monitoring wells to delineate vertical impacts in groundwater.

5.1.3.2 Soil Quality Delineation Locations

Additional soil borings are required to further delineate the extent of impact at Former Building 9. The approximate proposed locations of soil borings within each AOC are depicted on **Figure 4**. Soil boring locations will be chosen based on historical analytical data and information about the site as well as visual observations. These locations were chosen to evaluate the soil quality in the vicinity of the suspected contamination source areas. The proposed borings and purpose of each boring is summarized in **Table 3**. A summary of all the existing soil data is presented in **Table 1** and **Appendix B**. The results of the soil sample analyses will be used to develop a second phase of soil investigation at the Site. At each boring, one sample will be collected from the interval with the highest photoionization detector (PID) levels or greatest visual impact. If the samples do not exhibit PID levels above background or visual evidence of impact is not observed, then one sample will be collected from the interval above the water table.

5.1.3.3 Groundwater Quality Delineation Locations

Additional monitoring wells are required to further delineate the extent of impact at Former Building 9 and determine groundwater flow directions at the Site. The approximate proposed locations for groundwater monitoring wells are depicted on **Figure 4**. Groundwater sampling locations at each AOC will be decided on-Site during the subsurface investigation. Locations will be chosen based on historical analytical data, information about the site, visual observations, and the results from field analysis during the completion of soil borings. The installation of additional groundwater monitoring wells at the Site will help to define potential contaminant plumes at the Site to be further defined in a second phase of investigation. Additionally, the samples will serve to evaluate the potential for off-site migration of contaminated groundwater onto neighboring properties. The purpose behind the locations of the proposed monitoring wells is summarized in **Table 3**. A summary of all the existing groundwater data is presented in **Table 2** and **Appendix B**.

5.2 Investigation Methods

5.2.1 Health and Safety Plan

Prior to initiating field work, a Health and Safety Plan (HASP) consistent with OSHA 29 CFR regulations will be prepared. All on-Site contractors need to be covered Under a HASP and are required to have 40-hour OSHA training. The HASP is intended to address all known potential hazards on the Site. The HASP will remain on Site at all times during the investigation, and will be updated as new hazards become known, if any.

5.2.2 Soil Borings

Approximately 9 soil borings will be advanced at the Site (maximum depth of 30 ft or 10 feet below the water table, whichever is deeper) using hollow stemmed auger (HSA) or rotosonic drilling methods. Continuous samples will be collected and described using the Unified Soil Classification System (USCS). All soil samples will be screened for the presence of VOCs using a PID. Soil description and PID readings will be logged along with other pertinent observations including any visual evidence of contamination (e.g., staining, odor, sheen, etc.). Observations will be recorded in a field log book.

Soil samples for laboratory analysis will be collected as described in Section 5.2.4.

5.2.3 Groundwater Monitoring Well Installation

A total of 7 groundwater monitoring wells will be installed to define depth to groundwater and groundwater elevations at the Site. Two monitoring wells will be installed in the area of the former chrome plater (AOC-1), one monitoring well will be installed downgradient of the former TCE Degreasing Units (AOC-2A), one monitoring well will be installed in the Stormwater Pump and North Storage Area (AOC-3) where an LNAPL plume is suspected, and 3 monitoring wells will be installed along the expected upgradient boundary of the property.

Depths of wells will be determined based on historical information and on-site observations. The wells will be constructed of 2-inch diameter, schedule 40 PVC with a 10-foot stainless steel wire wrapped screen that will be installed to straddle the water table. During a future drilling mobilization, deeper paired wells may be installed adjacent to these water table wells to assess the potential for vertical contaminant migration, depending on the results of this investigation. A sand pack will be installed around the screen and extended two feet above the screen. The remaining annulus will be sealed with hydrated bentonite pellets. The well will be completed with a two foot tall metal casing around the well to ensure visibility of the monitoring well at the Site during future sampling events.

The wells will be developed using a submersible pump or disposable polyethylene bailer. The pump or bailer will be raised and lowered ("surged") across the entire screen length to remove sediment from the well and sand pack. Development will continue until the water is relatively sediment-free and development criteria are reached. Purge water will be containerized in 55-gallon steel drums and shipped off-site upon proper characterization.

5.2.4 Soil and Groundwater Sampling

Groundwater and soil sampling and subsequent laboratory analyses will be completed in accordance with the Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP) for this Site, which have been prepared as companion documents to this Work Plan. In general, these activities will adhere to the guidance provided in the MDEQ's Remediation and Redevelopment Division (RRD) *Operational Memorandum No. 2, Sampling and Analysis* (Op Memo 2) (MDEQ, 2004a). Op Memo 2 and the associated attachments that pertain to this investigation are presented in **Appendix C**, including:

- Target Detection Limits and Designated Analytical Methods (Attachment 1)
- Sample Preservation, Sample Handling, and Holding Time Specifications (Attachment 4)
- Collection of Samples for Comparison to Generic Criteria (Attachment 5)
- Sampling Methods for Volatile Organic Compounds in Soil (Attachment 6)

Soil samples for laboratory analysis will be collected from the 0-6 inch bgs interval because potential impacts were generally believed to be at the surface. Additional samples may be collected if impacted soil is encountered based on PID readings and visual observations. If there is no evidence of impact throughout the sample, an additional sample may be collected from the interval above the water table if deemed necessary. The samples will be field preserved with methanol for VOC analysis.

Groundwater samples will be collected from each new and existing monitoring well using a peristaltic or bladder pump and disposable tubing to prevent cross contamination, as described in the FSP. Samples will be collected using low-flow sampling technique. Field readings of water quality parameters including; pH, specific conductivity, temperature, dissolved oxygen, oxidation-reduction potential, and turbidity will be recorded during purging to determine stabilization prior to sampling.

5.2.5 Quality Control Samples

In accordance with MDNRE Operational Memo 2, Attachment 5, quality control (QC) samples will be collected for analysis to evaluate laboratory and field sampling precision. QC samples will be collected as follows:

- One field duplicate sample will be collected for every 20 investigation samples.
- One set of matrix spike/matrix spike duplicate (MS/MSD) samples will be collected for every sample batch submittal (maximum of 20 samples per batch).
- One trip blank, to be provided by the laboratory, will be submitted with every sample batch.
- One equipment blank will be submitted during the investigation by pouring lab-grade distilled water over the disposable polyethylene sample tubing and

collecting the runoff. In addition, one equipment blank will be collected per day by pouring lab-grade distilled water over the decontaminated drill tooling and collecting the runoff.

The QC samples will be submitted for analysis of the COCs listed in Section 5.2.7.

5.2.6 Analytical Constituents

Based on historical investigation data, the COCs related to the previous site releases are VOCs and SVOCs, primarily chlorinated ethenes. Polychlorinated biphenyls (PCBs) were also commonly used at the Site. VOCs, SVOCs, PCBs, Michigan-10 metals (arsenic, barium, cadmium, chromium, copper, lead, mercury, silver, selenium, zinc) plus nickel and cyanide, will be included as part of the analyses proposed in this Work Plan. The list of COCs to be analyzed at each soil and groundwater sample is presented in **Table 3**.

5.2.7 Laboratory Analysis

Laboratory analyses will be completed in accordance with the USEPA's *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846) (USEPA, 1994) as defined in Op Memo 2, Attachment 1. All soil and groundwater samples will be analyzed for the target compound list (TCL) VOCs, SVOCs, and PCBs in accordance with USEPA Methods 8260B, 8270C, 8082A/8270C, respectively. Samples will also be analyzed for metals in accordance with USEPA Method 6000 and 7000.

All samples will be submitted to an accredited laboratory for analysis.

5.2.8 Surveying

All boring and monitoring well locations will be surveyed by a licensed surveyor. Elevations will be surveyed using the North American Vertical Datum (1988) reference system. Horizontal locations will be surveyed to the Michigan South State Plane reference system.

5.2.9 Waste Handling

Soil cuttings and purge water generated from the investigative activities will be placed into 55-gallon Michigan Department of Transportation (MDOT)-approved drums and properly labeled and secured. Samples will be collected from the drums for waste characterization. Upon characterization, the drums will be transported and appropriately disposed of by a licensed transport and disposal contractor.

5.3 Data Evaluation

5.3.1 Relevant Exposure Pathways

To evaluate the groundwater and soil sample results, the relevant potential contaminant exposure pathways have been evaluated.

The nearest surface water (Flint River) is approximately 1/10 mile north of the Site. Groundwater flow within the shallow saturated zone is toward the Flint River, but may also flow toward Swartz Creek. Because the extent of groundwater impacts off the property have not been delineated, the GSI pathway remains relevant until and unless the plume has attenuated before discharging to the surface water body. Furthermore, although the shallow groundwater is not used as a drinking water supply, because there is no known property restriction on the use of groundwater in the area, the drinking water pathway also remains relevant at this time. However, because MLC owns the property they can institute a deed restriction on the property to prohibit use of groundwater at the Site.

Based on Site conditions, the ambient air and direct contact exposure pathways are relevant. In addition, although there is currently no building on the property, the indoor air inhalation pathway is relevant to account for possible future development.

Based on current Site conditions and possible future use of the Site, the following exposure pathways are relevant:

- Indoor air inhalation (soil and groundwater)
- Ambient air inhalation (soil and groundwater)
- Particulate inhalation (soil)
- Direct contact (soil and groundwater).
- GSI protection and GSI (soil and groundwater , respectively)
- Drinking water protection and drinking water off-Site (soil and groundwater respectively)

Based upon the relatively small size of the Building 9 property, completion of a Site-Specific Risk Assessment is not anticipated but the data will be useable for a risk assessment should one be appropriate. Soil and groundwater quality results will be compared to and future remedial responses will be based on the applicable Part 201 Cleanup Criteria as discussed in Section 5.3.2.

5.3.2 Applicable Cleanup Criteria

Based on the relevant exposure pathways described above, the applicable Part 201 Cleanup Criteria were selected. The current Site zoning is industrial and will most likely remain industrial for the foreseeable future. In addition, as owner of the Site, MLC can institute a deed restriction on the property to prohibit future non-industrial/commercial use of the property. Zoning for the surrounding properties is uncertain at this time. Development plans for the former Chevy-in-the-Hole property to the north (see **Figure 2**) have included some limited residential and parkland. Therefore, at this time the applicable cleanup criteria for the Site should be considered "Industrial and Commercial II, III and IV" and the surrounding properties considered "Residential and Commercial I" as presented in the MDEQ RRD *Op Memo No. 1, Part 201 Cleanup Criteria and Risk-Based Screening Levels* (MDEQ, 2004b).

The applicable criteria for each relevant exposure pathway described in Section 5.3.1 are shown in **Tables 1** and **2**.

Analytical results from the proposed soil and groundwater samples to be collected will be compared to the applicable Part 201 cleanup criteria to determine the extent of contamination. However, should it be appropriate, site-specific risk based cleanup criteria may be developed.

5.4 Reporting

A summary report will be prepared to present the findings of the investigation. The report will include sample results, geologic cross sections, data evaluation, a groundwater contour map and the proposed follow-up investigation activities. The summary report of the findings will be submitted to USEPA for review.

6. References

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TABLES

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Tables

Table 1

Historical Soil Sample Results - Detected Constituents
Proposed Investigation Locations
Former Building 9 - Delphi Flint West
Flint, Michigan

Area of Concern	Constituents Detected Over Criteria	Highest Concentration (mg/kg)
AOC-1	Arsenic	13 (RDC,RDC-SDBL,SDBL)
AOC-1	Barium	100 (SDBL)
AOC-1	Chromium Total	23 (GSIP,GSIP-SDBL,SDBL)
AOC-1	Lead	180 (SDBL)
AOC-1	Zinc	220 (SDBL)
AOC-2A	cis-1,2-Dichloroethene	1.8 J (IDWP,IDWP-SDBL,RDWP,RDWP-SDBL)
AOC-2A	Trichloroethene	3 J (IDWP,IDWP-SDBL,RDWP,RDWP-SDBL)
AOC-2A	Arsenic	12 (RDC,RDC-SDBL,SDBL)
AOC-2A	Barium	130 J (SDBL)
AOC-2A	Chromium Total	20 J (GSIP,GSIP-SDBL,SDBL)
AOC-2A	Lead	280 J (SDBL)
AOC-2A	Mercury	0.29 J (GSIP,GSIP-SDBL,SDBL)
AOC-2A	Nickel	27 J (SDBL)
AOC-2A	Zinc	200 J (SDBL)
AOC-2B	Trichloroethene	0.67 (IDWP,IDWP-SDBL,RDWP,RDWP-SDBL)
AOC-2B	Arsenic	12 (RDC,RDC-SDBL,SDBL)
AOC-2B	Barium	89 (SDBL)
AOC-2B	Chromium Total	28 (GSIP,GSIP-SDBL,SDBL)
AOC-2B	Selenium	0.67 (GSIP,GSIP-SDBL,SDBL)
AOC-2B	Zinc	66 (SDBL)
AOC-3	Chromium Total	13 (GSIP)
AOC-3	Selenium	0.51 (GSIP,GSIP-SDBL,SDBL)

Notes:

mg/kg	milligrams per kilogram
GSIP	Groundwater Surface Water Interface Protection Criteria
GSIP-SDBL	Groundwater Surface Water Interface Protection Criteria - Statewide Default Background Levels
IDWP	Industrial & Commercial Drinking Water Protection Criteria
IDWP-SDBL	Industrial & Commercial Drinking Water Protection Criteria - Statewide Default Background Levels
RDC	Residential & Commercial I Direct Contact Values
RDC-SDBL	Residential & Commercial I Direct Contact Values - Statewide Default Background Levels
SDBL	Statewide Default Background Levels

Table 2

Historical Groundwater Sample Results - Detected Constituents
Proposed Investigation Locations
Former Building 9 - Delphi Flint West
Flint, Michigan

Area of Concern	Constituents Detected Over Criteria	Highest Concentration (mg/L)
AOC-2A	cis-1,2-Dichloroethene	0.19 J (IDW,IDW-A,RDW,RDW-A)
AOC-2A	Trichloroethene	0.25 J (IDW,IDW-A,RDW,RDW-A)
AOC-2A	Vinyl chloride	0.007 (IDW,IDW-A,RDW,RDW-A) [0.012 (IDW,IDW-A,RDW,RDW-A)]
AOC-2A	Total PCBs	0.0031 J (IDW,IDW-A,RDW,RDW-A)
AOC-2A	Lead (Dissolved)	0.01 J (IDW,IDW-A,RDW,RDW-A)
AOC-2B	cis-1,2-Dichloroethene	1 (IDW,IDW-A,RDW,RDW-A)
AOC-2B	Methyl Tert Butyl Ether	0.12 (IDW-A,RDW-A)
AOC-2B	Trichloroethene	0.35 (IDW,IDW-A,RDW,RDW-A)
AOC-2B	Vinyl chloride	0.19 (IDW,IDW-A,RDW,RDW-A)
AOC-3	Trichloroethene	0.01 J (IDW,IDW-A,RDW,RDW-A)

Notes:

mg/L	milligrams per liter
IDW	Generic Industrial Drinking Water Value-Health Based
IDW-A	Generic Industrial Drinking Water Value-Aesthetic Based
RDW	Generic Residential Drinking Water Values-Health Based
RDW-A	Generic Residential Drinking Water Values-Aesthetic Based

Table 3

Proposed Investigation Locations
Investigation Work Plan
Former Building 9 - Delphi Flint West
Flint, Michigan

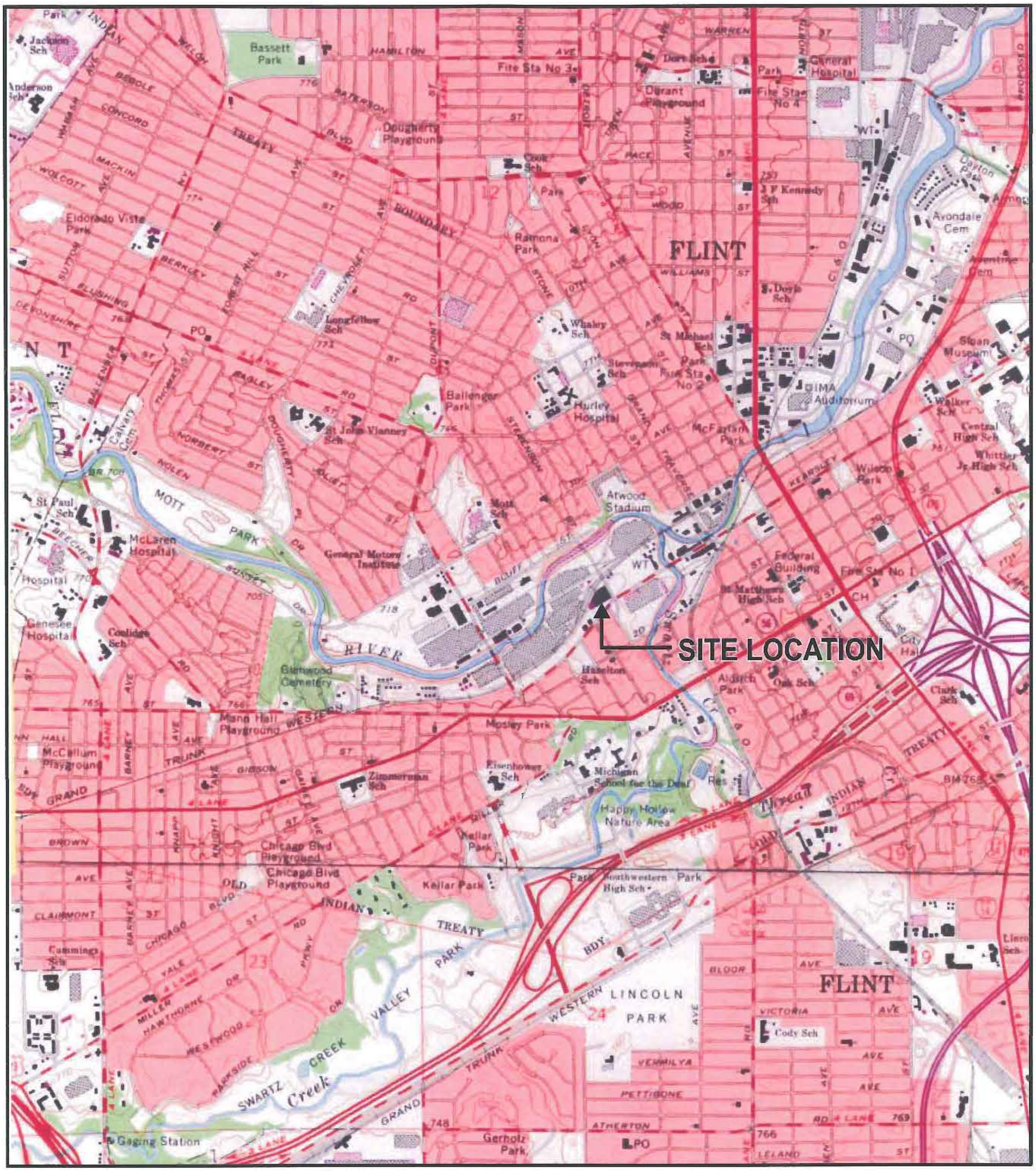
Proposed Sample Locations	Purpose	Constituents to be Sampled
2 Soil Borings will be installed in the vicinity of AOC-1.	Soil borings will be installed in the vicinity of AOC-1, to a maximum depth of 30 ft bgs or 10 feet below the water table, whichever is deeper, to verify historic soil sample concentrations, define the conditions at the Site, and confirm whether the Site had previously been clean closed.	VOCs, SVOCs, PCBs, Michigan 10 Metals, cyanide.
2 Monitoring Wells will be installed in the vicinity of AOC-1.	Monitoring wells will be installed in the vicinity of the Former Chrome Plater to verify historic groundwater concentrations, determine whether the Site had previously been clean closed, and to enable future groundwater monitoring.	VOCs, SVOCs, Michigan 10 Metals, cyanide, and general water quality parameters.
2 Soil Borings will be installed in the vicinity of AOC-2.	Soil Borings will be installed in the vicinity of AOC-2A (former TCE degreasing unit) and AOC-2B (gravel area, northwest side of Building 9), to a maximum depth of 30 ft bgs or 10 feet below the water table, whichever is deeper. One soil boring will be installed in the southern portion of the Site near the former TCE Degreasing Units, and 1 in the gravel area. The boring locations were chosen to verify historic concentrations in the area and to investigate the presence of a possible TCE plume at the Site.	VOCs, SVOCs, PCBs, Michigan 10 Metals, cyanide.
1 Monitoring Well will be installed in the vicinity of AOC-2.	A monitoring well will be installed in the vicinity of AOC-2 based on field observations (staining, odor, elevated PID readings, etc) during soil boring installation in the area. This monitoring well will be installed to verify historic groundwater concentrations and to define the conditions in the area. The monitoring well will also allow future groundwater monitoring at the Site.	VOCs, SVOCs, Michigan 10 Metals, cyanide, and general water quality parameters.
1 Soil Boring will be installed in the vicinity of AOC-3.	A soil boring will be installed to a maximum depth of 30 ft bgs or 10 feet below the water table, whichever is deeper, to verify historical concentrations and to determine the presence of LNAPL and other constituents in the vicinity of the Former Stormwater Pump and North Storage Area.	VOCs, SVOCs, PCBs, Michigan 10 Metals, cyanide.
1 Monitoring well will be installed in the vicinity of AOC-3.	A monitoring well will be installed in the vicinity of AOC-3 based on field observations (staining, odor, elevated PID reading, etc) during soil boring installation. The monitoring well will be installed to determine the presence of LNAPL and other constituents in the groundwater. Installing a monitoring well in this area will enable future groundwater monitoring at the Site.	VOCs, SVOCs, Michigan 10 Metals, cyanide, and water quality parameters.
3 Soil Borings will be installed at the southern and eastern Site boundaries.	Soil Borings will be installed along property boundaries to a maximum depth of 30 ft bgs or 10 feet below the water table, whichever is deeper, to investigate the potential presence of constituents of concern.	VOCs, SVOCs, PCBs, Michigan 10 Metals, cyanide.
3 Monitoring wells will be installed at the southern and eastern Site boundaries.	Monitoring wells will be installed during soil boring installation in these locations. The monitoring wells will be installed to determine the presence of constituents in the groundwater and groundwater flow direction at the southern and eastern property boundaries. Installing monitoring wells in these locations will enable future groundwater monitoring at the Site.	VOCs, SVOCs, Michigan 10 Metals, cyanide, and general water quality parameters.

Notes:
AOC: Area of Concern
ft bgs: feet below ground surface
Michigan 10 Metals include arsenic, barium, cadmium, chromium, lead, mercury, nickel, silver, selenium, and zinc.
VOCs: volatile organic compounds
SVOCs: semi-volatile organic compounds
PCBs: polychlorinated biphenyls
General water quality parameters include alkalinity, ammonia, chloride, nitrate/nitrite, sulfate, hardness, total dissolved solids, and total organic carbon.

FIGURES

ARCADIS

Figures



MAP SOURCE: UNITED STATES GEOLOGIC SURVEY TOPOGRAPHIC QUADRANGLE, 7.5 MIN. SERIES, FLINT NORTH & FLINT SOUTH, MICHIGAN, (1969).

2000 0 2000

APPROXIMATE SCALE IN FEET

MOTORS LIQUIDATION COMPANY
FORMER BUILDING 9, DELPHI - FLINT WEST FACILITY
FLINT, MICHIGAN

INVESTIGATION WORK PLAN

SITE LOCATION MAP

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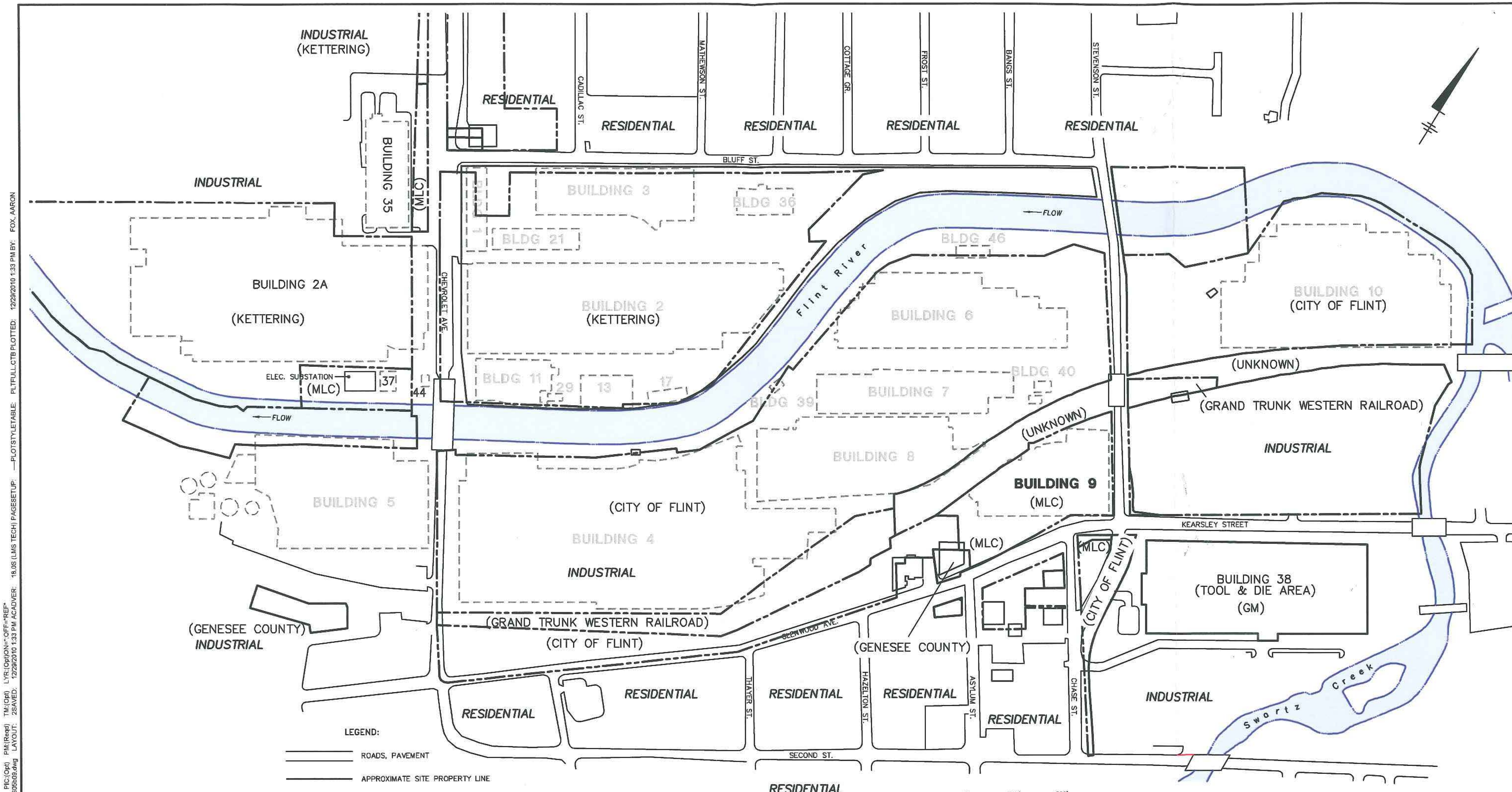
FIGURE
1

12/28/2010 SYRACUSE, NY-ENV/CAD - K.SARTORI
B0064605/2010/00002/CDR/64605N01.CDR



LEGEND:

- ROADS, PAVEMENT
- APPROXIMATE SITE PROPERTY LINE
- CONCRETE CHANNELIZED FLINT RIVER
- MAJOR BUILDING, PLANT
- MINOR BUILDING
- FORMER BUILDING LOCATION
- BLDG — BUILDING
- *RESIDENTIAL* — RESIDENTIAL ZONING
- *INDUSTRIAL* — INDUSTRIAL ZONING
- (DELPHI) — OWNER
- APPROXIMATE PROPERTY BOUNDARY

0 150' 300'
APPROXIMATE SCALE

NOTES:

1. BASE MAP DIGITIZED FROM "GROUNDWATER ELEVATION MAP" FROM O'BRIEN & GERE, ENGINEERS, INC. (9/95), FILE NUMBER 5858-014-003, FIGURE 3. SOURCE SCALE IS 1"=200'.
2. ALL LOCATIONS AND FEATURES ARE APPROXIMATE ONLY.
3. GM = GENERAL MOTORS CORPORATION
   KETTERING = KETTERING UNIVERSITY
   MLC = MOTORS LIQUIDATION COMPANY
4. FORMER BUILDINGS 1, 3, 11, 13, 17, 21, 29, 36, 37, AND 44 BELONG TO KETTERING UNIVERSITY.
5. EXTENT OF PROPERTY OWNERSHIP IS APPROXIMATE.
6. PROPERTY BOUNDARIES BASED ON INFORMATION FROM GENESEE COUNTY GIS DEPARTMENT & CITY OF FLINT ASSESSMENT DIVISION.

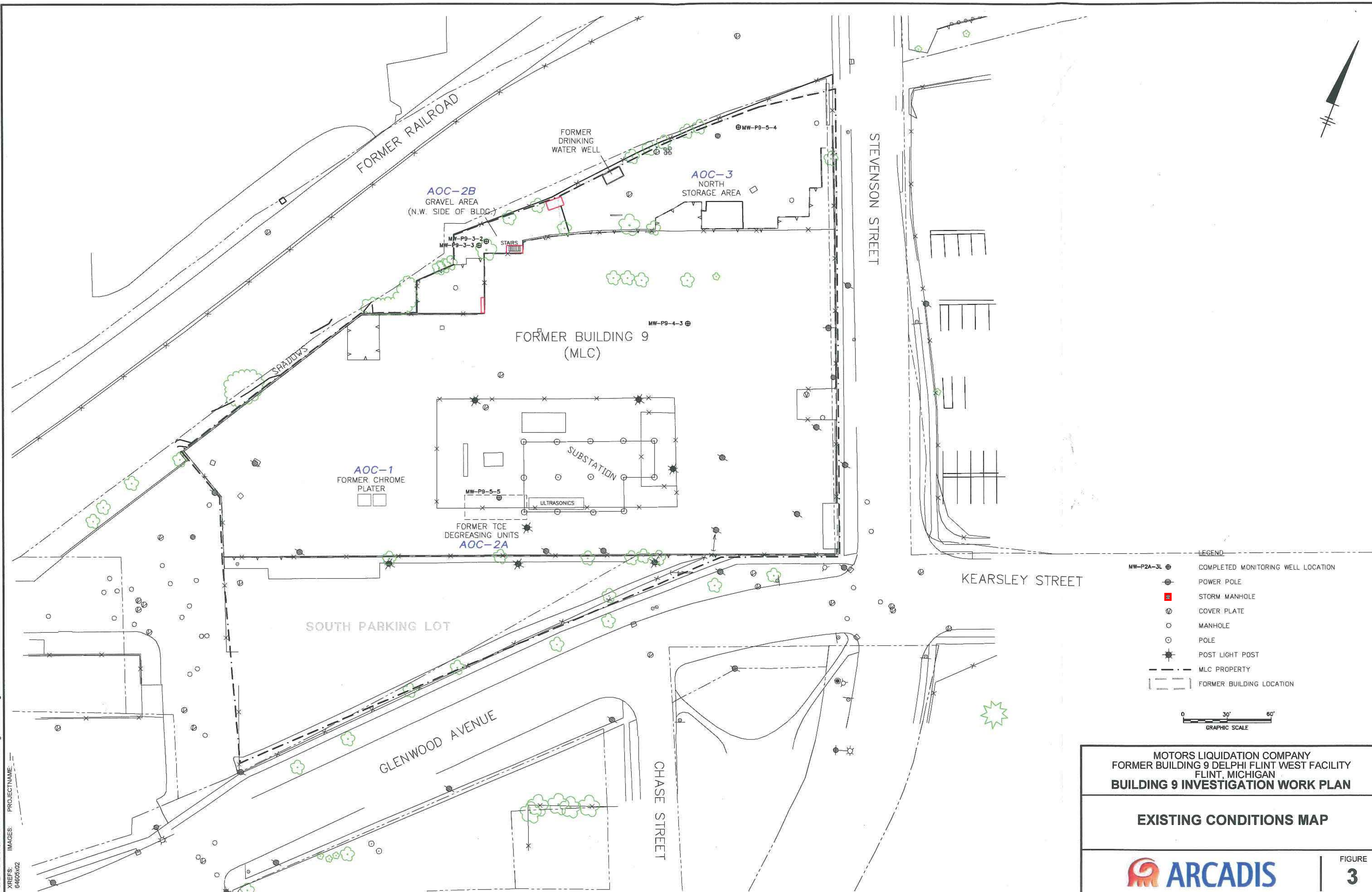
MOTORS LIQUIDATION COMPANY
FORMER BUILDING 9 FORMER DELPHI FLINT WEST FACILITY
FLINT, MICHIGAN
BUILDING 9 INVESTIGATION WORK PLAN

SURROUNDING LAND USE MAP

ARCADIS

FIGURE
2

CITY:BRIGHTON DIV/GROUP: 141 DB: ADF LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\BRIGHTON\ACT\B0064605\2010\00002\dwg\64605b09.dwg LAYOUT: 2SAVED: 12/29/2010 1:33 PM ACADVER: 18.0S (LMS TECH) PAGESETUP: —PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 12/29/2010 1:33 PM BY: FOX, AARON
XREFS: 64605x02 64605C02 64605X00C IMAGES: PROJECTNAME: —

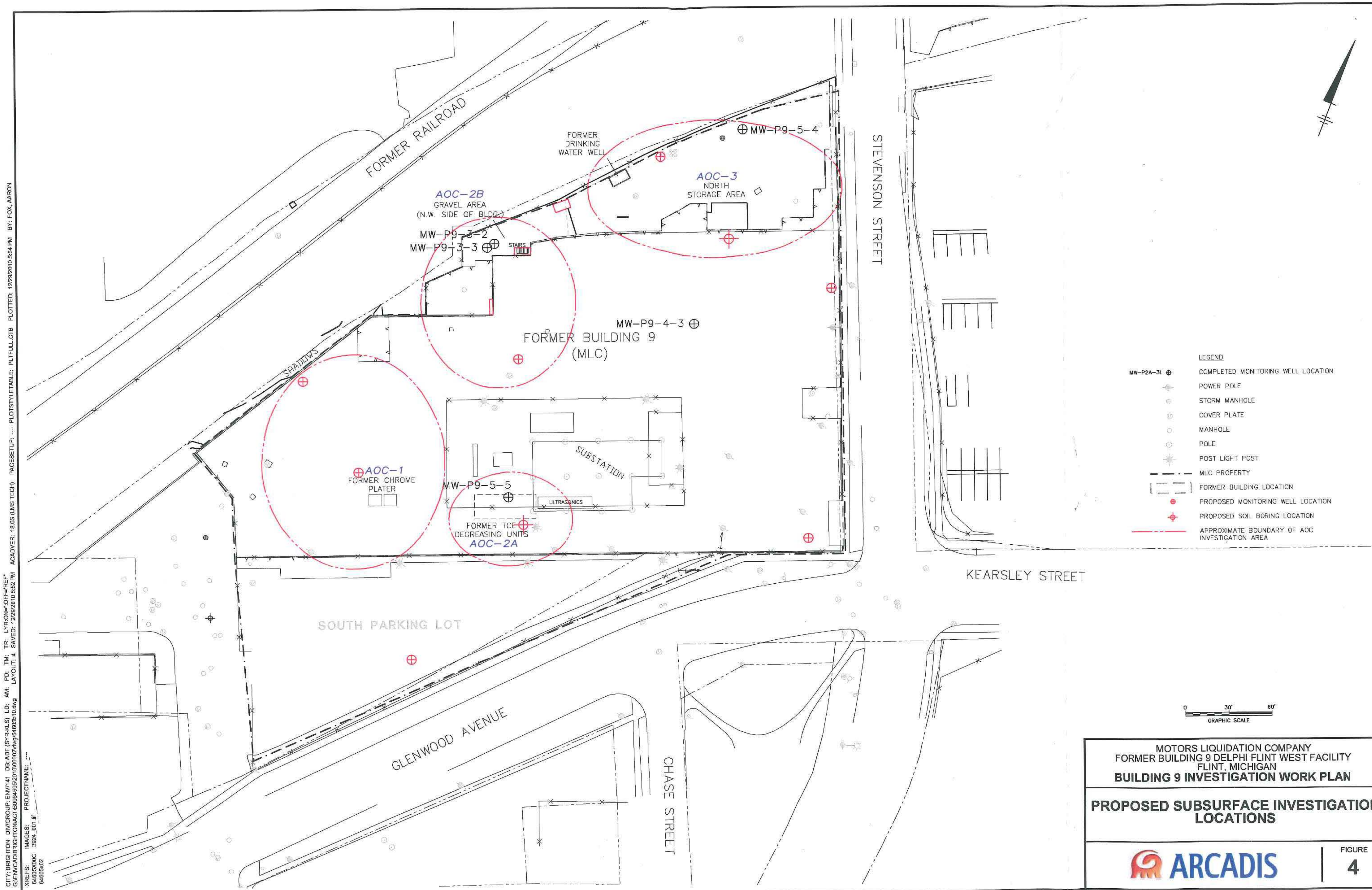


MOTORS LIQUIDATION COMPANY
FORMER BUILDING 9 DELPHI FLINT WEST FACILITY
FLINT, MICHIGAN
BUILDING 9 INVESTIGATION WORK PLAN

EXISTING CONDITIONS MAP

ARCADIS

FIGURE
3



MOTORS LIQUIDATION COMPANY
FORMER BUILDING 9 DELPHI FLINT WEST FACILITY
FLINT, MICHIGAN

BUILDING 9 INVESTIGATION WORK PLAN

PROPOSED SUBSURFACE INVESTIGATION LOCATIONS

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FIGURE

4

APPENDICES

APPENDIX A

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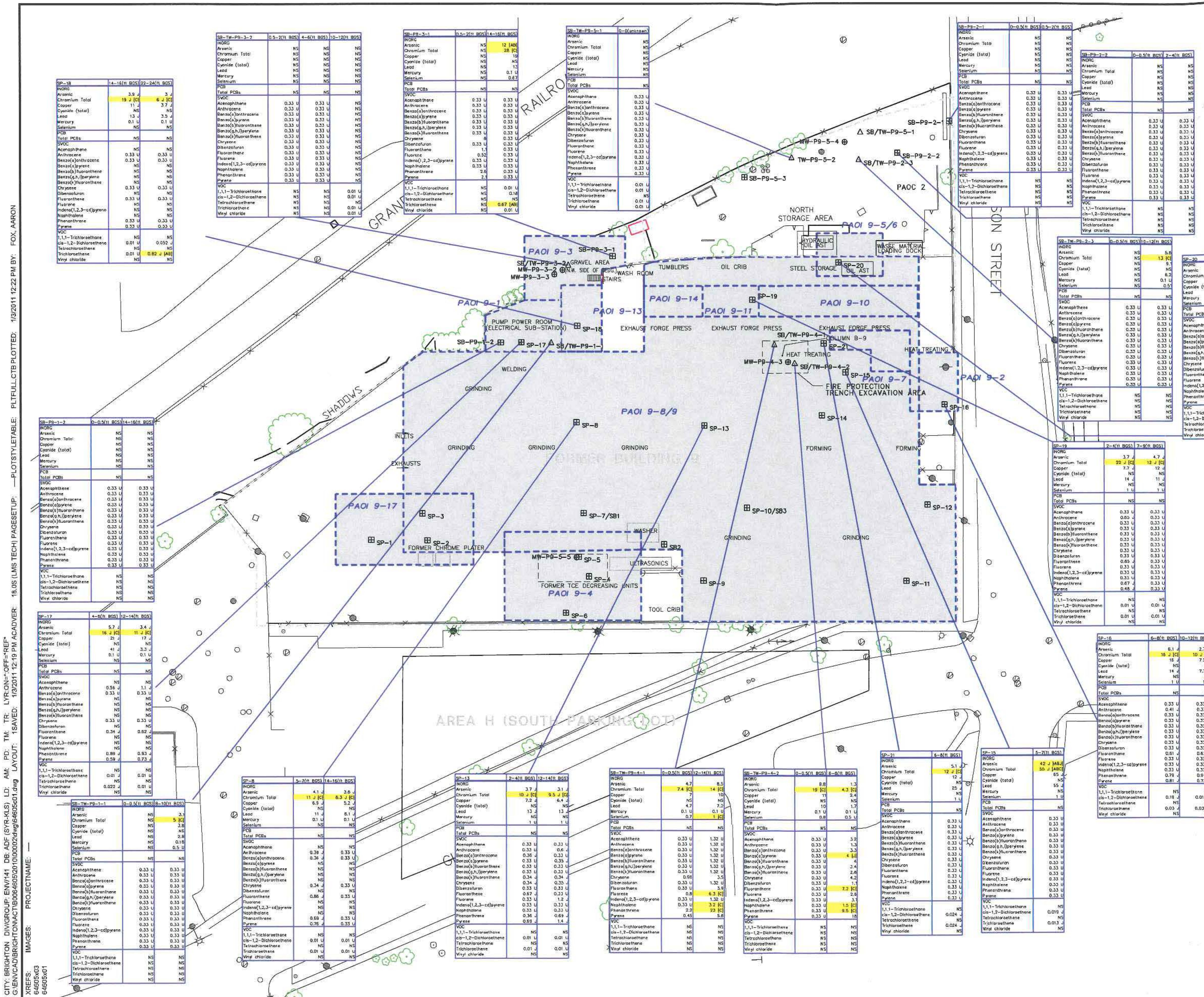
Appendix A

Historic Analytical Data Figures



LEGEND:

- FORMER BUILDING LOCATION
- SB-13 ⊞ SOIL BORING–NO OIL IN SOIL AND/OR WATER OBSERVED
- MW-P2A-3L ⊕ COMPLETED MONITORING WELL LOCATION – NO OIL IN SOIL AND/OR WATER OBSERVED
- TW/SB-P9-2-3 △ SOIL BORING WITH TEMPORARY WELL
- POWER POLE
- STORM MANHOLE
- COVER PLATE
- MANHOLE
- POLE POST
- LIGHT POST
- POTENTIAL AREA OF INTEREST (PAOI)

SP-20	5-7(ft BGS)	11-13(ft BGS)
INORG		
Arsenic	4.9 J	2.4 J
Chromium Total	11 J [C]	4.3 J [C]
Copper	11 J	3.6 J
Cyanide (total)	NS	NS
Lead	13 J	4.4 J
Mercury	NS	NS
Selenium	1 U	1 U
PCB		
Total PCBs	NS	NS
SVOC		
Acenaphthene	0.33 U	0.33 U
Anthracene	0.33 U	0.33 U
Benzo(a)anthracene	0.33 U	0.33 U
Benzo(a)pyrene	0.33 U	0.33 U
Benzo(b)fluoranthene	0.33 U	0.33 U
Benzo(g,h,i)perylene	0.33 U	0.33 U
Benzo(k)fluoranthene	0.33 U	0.33 U
Chrysene	0.33 U	0.33 U
Dibenzofuran	0.33 U	0.33 U
Fluoranthene	0.33 U	0.33 U
Fluorene	0.33 U	0.33 U
Indeno(1,2,3-cd)pyrene	0.33 U	0.33 U
Naphthalene	0.33 U	0.33 U
Phenanthrene	0.33 U	0.33 U
Pyrene	0.33 U	0.33 U
VOC		
1,1,1-Trichloroethane	NS	NS
cis-1,2-Dichloroethene	0.01 U	0.01 U
Tetrachloroethene	NS	NS
Trichloroethene	0.01 U	0.01 U
Vinyl chloride	NS	NS

NOTES/ACRONYMS:

- B – METHOD BLANK CONTAMINATION
- DCC – DIRECT CONTACT CRITERIA
- DWP – DRINKING WATER PROTECTION CRITERIA
- GSIP – GROUNDWATER SURFACE WATER INTERFACE PROTECTION
- GCCP – GROUNDWATER CONTACT CRITERIA PROTECTION
- INORG – INORGANICS
- J – ESTIMATED VALUE
- M – RESULT REPORTED TO MDL NOT RDL
- NS – NOT SAMPLED
- PCB – POLYCHLORINATED BIPHENYLS
- PSIC – PARTICULATE SOIL INHALATION CRITERIA
- S – SURROGATE RECOVERY OUTSIDE OF CONTROL LIMITS
- SVIIC – SOIL VOLATILIZATION TO INDOOR AIR INHALATION CRITERIA
- SVOCs – SEMI-VOLATILE ORGANIC COMPOUNDS
- U – NON-DETECT AT ASSOCIATED VALUE
- VOCs – VOLATILE ORGANIC COMPOUNDS
- VSIC – INFINITE SOURCE VOLATILE SOIL INHALATION CRITERIA
- X – ELEVATED REPORTING LIMIT DUE TO MATRIX INTERFERENCE
- Y – ELEVATED REPORTING LIMIT DUE TO HIGH TARGET CONCENTRATION

EXCEEDANCE CODES

- [A] – MDEQ Residential DWP
- [B] – MDEQ Industrial DWP
- [C] – MDEQ GSIP
- [D] – MDEQ Residential SVIIC
- [E] – MDEQ Industrial SVIIC
- [F] – MDEQ Residential VSIC
- [G] – MDEQ Industrial VSIC
- [H] – MDEQ Residential PSIC
- [I] – MDEQ Industrial PSIC
- [J] – MDEQ Residential DCC
- [K] – MDEQ Industrial DCC

NOTES:

1. SOIL CONCENTRATIONS ARE HIGHLIGHTED WHEN FACILITY-RELATED CONCENTRATIONS (SEE NOTE 2) ARE HIGHER THAN THE RESIDENTIAL OR INDUSTRIAL SCREENING LEVELS FOR DWP, GSIP, VSIC, PSIC, DC, AND THE RISK-BASED REDEVELOPMENT WORKER CONTACT.
2. FACILITY-RELATED SOIL CONCENTRATIONS ARE THOSE IN EXCESS OF THE BACKGROUND LEVELS. STATEWIDE DEFAULT BACKGROUND LEVELS PUBLISHED WITH PART 201 GENERIC CLEANUP CRITERIA AND SCREENING LEVELS ARE USED AS BACKGROUND LEVELS.

LOCATION — ANALYTE — DEPTH (FEET BELOW GROUND SURFACE) — VALIDATION CODE — EXCEEDANCE CODE — CONCENTRATION IN mg/kg — DUPLICATE SAMPLE CONCENTRATION IN mg/kg

MW-14SR	10-12(ft BGS)
INORG	
Chromium Total	75.7/93.2
Cyanide (total)	NS/NS
Lead	2080 J [MN]/6200 J [MN]

0 30' 60'

GRAPHIC SCALE

MOTORS LIQUIDATION COMPANY
FORMER BUILDING 9 DELPHI FLINT WEST FACILITY
FLINT, MICHIGAN

BUILDING 9 INVESTIGATION WORK PLAN

ANALYTES IN SOIL - NORTHERN PORTION FORMER BUILDING 9 AREA DATABOX EXCEEDANCES MAP

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FIGURE 1

CITY: BRIGHTON DIV/GROUP: ENV/141 DB: ADF (SYR-KLS) LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF* PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 1/3/2011 12:22 PM BY: FOX, AARON
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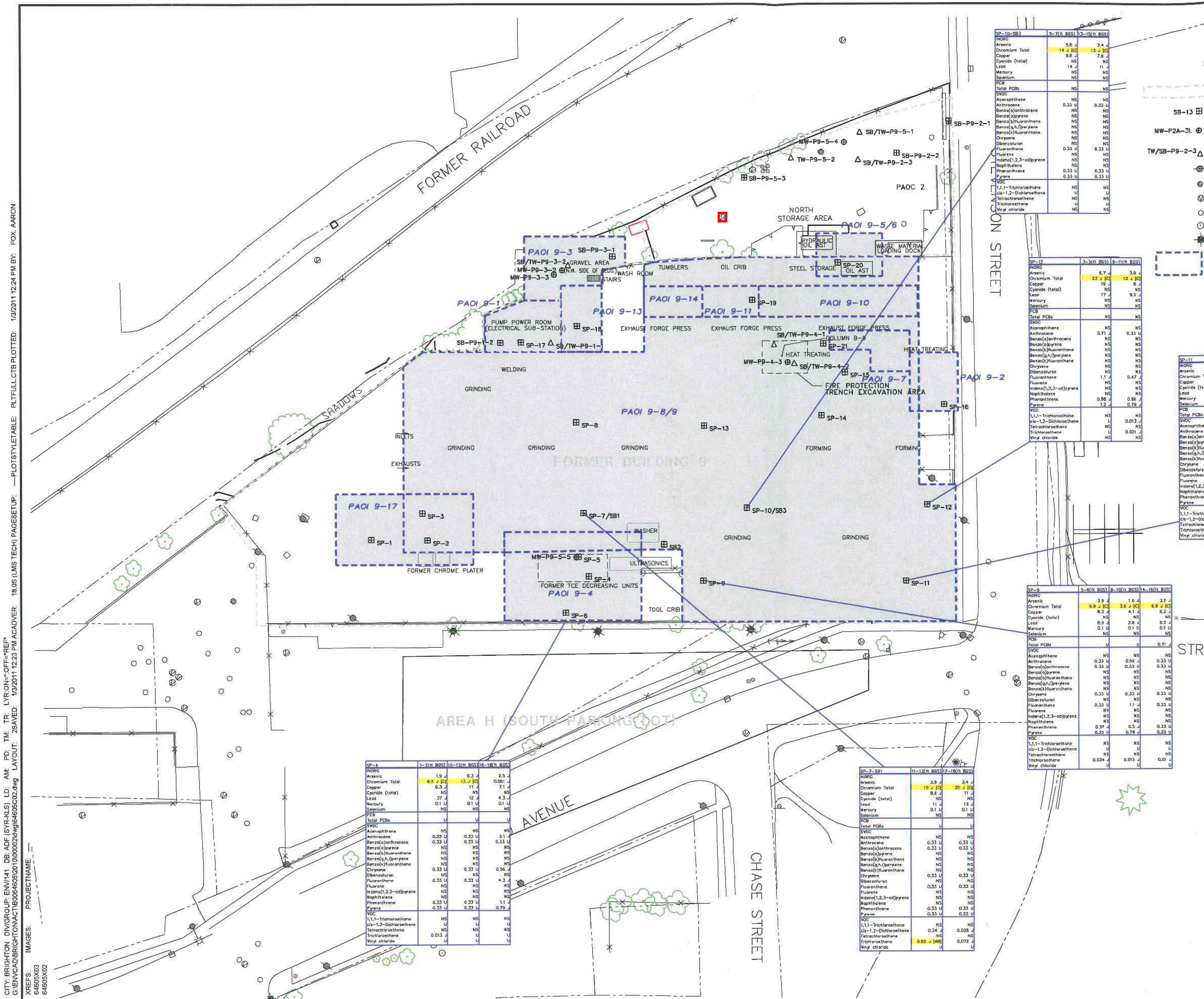


SP-10-SB3	5-7(ft BGS)	13-15(ft BGS)
INORG		
Arsenic	5.6 J	2.4 J
Chromium Total	14 J [C]	13 J [C]
Copper	9.8 J	7.6 J
Cyanide (total)	NS	NS
Lead	14 J	11 J
Mercury	NS	NS
Selenium	NS	NS
PCB		
Total PCBs	NS	NS
SVOC		
Acenaphthene	NS	NS
Anthracene	0.33 U	0.33 U
Benzo(a)anthracene	NS	NS
Benzo(a)pyrene	NS	NS
Benzo(b)fluoranthene	NS	NS
Benzo(g,h,i)perylene	NS	NS
Benzo(k)fluoranthene	NS	NS
Chrysene	NS	NS
Dibenzofuran	NS	NS
Fluoranthene	0.33 U	0.33 U
Fluorene	NS	NS
Indeno(1,2,3-cd)pyrene	NS	NS
Naphthalene	NS	NS
Phenanthrene	0.33 U	0.33 U
Pyrene	0.33 U	0.33 U
VOC		
1,1,1-Trichloroethane	NS	NS
cis-1,2-Dichloroethene	U	U
Tetrachloroethene	NS	NS
Trichloroethene	U	U
Vinyl chloride	NS	NS

SP-12	3-5(ft BGS)	9-11(ft BGS)
INORG		
Arsenic	6.7 J	3.9 J
Chromium Total	23 J [C]	13 J [C]
Copper	19 J	8 J
Cyanide (total)	NS	NS
Lead	17 J	9.2 J
Mercury	NS	NS
Selenium	NS	NS
PCB		
Total PCBs	NS	NS
SVOC		
Acenaphthene	NS	NS
Anthracene	0.71 J	0.33 U
Benzo(a)anthracene	NS	NS
Benzo(a)pyrene	NS	NS
Benzo(b)fluoranthene	NS	NS
Benzo(g,h,i)perylene	NS	NS
Benzo(k)fluoranthene	NS	NS
Chrysene	NS	NS
Dibenzofuran	NS	NS
Fluoranthene	1.1 J	0.47 J
Fluorene	NS	NS
Indeno(1,2,3-cd)pyrene	NS	NS
Naphthalene	NS	NS
Phenanthrene	0.98 J	0.86 J
Pyrene	1.2 J	0.79 J
VOC		
1,1,1-Trichloroethane	NS	NS
cis-1,2-Dichloroethene	U	0.013 J
Tetrachloroethene	NS	NS
Trichloroethene	U	0.021 J
Vinyl chloride	NS	NS

SP-11	4-6(ft BGS)
INORG	
Arsenic	5.1 J
Chromium Total	8.6 J [C]
Copper	13 J
Cyanide (total)	NS
Lead	68 J
Mercury	NS
Selenium	NS
PCB	
Total PCBs	NS
SVOC	
Acenaphthene	NS
Anthracene	0.33 U
Benzo(a)anthracene	NS
Benzo(a)pyrene	NS
Benzo(b)fluoranthene	NS
Benzo(g,h,i)perylene	NS
Benzo(k)fluoranthene	NS
Chrysene	NS
Dibenzofuran	NS
Fluoranthene	0.33 U
Fluorene	NS
Indeno(1,2,3-cd)pyrene	NS
Naphthalene	NS
Phenanthrene	0.33 U
Pyrene	0.33 U
VOC	
1,1,1-Trichloroethane	NS
cis-1,2-Dichloroethene	U
Tetrachloroethene	NS
Trichloroethene	U
Vinyl chloride	NS

SP-9	5-6(ft BGS)	8-10(ft BGS)	14-16(ft BGS)
INORG			
Arsenic	3.9 J	1.6 J	3.7 J
Chromium Total	6.9 J [C]	3.6 J [C]	6.9 J [C]
Copper	8.3 J	4.1 J	6.2 J
Cyanide (total)	NS	NS	NS
Lead	8.9 J	3.8 J	6.2 J
Mercury	0.1 U	0.1 U	0.1 U
Selenium	NS	NS	NS
PCB			
Total PCBs	U	U	0.71 J
SVOC			
Acenaphthene	NS	NS	NS
Anthracene	0.33 U	0.56 J	0.33 U
Benzo(a)anthracene	0.33 U	0.33 U	0.33 U
Benzo(a)pyrene	NS	NS	NS
Benzo(b)fluoranthene	NS	NS	NS
Benzo(g,h,i)perylene	NS	NS	NS
Benzo(k)fluoranthene	NS	NS	NS
Chrysene	0.33 U	0.33 U	0.33 U
Dibenzofuran	NS	NS	NS
Fluoranthene	0.33 U	1.1 J	0.33 U
Fluorene	NS	NS	NS
Indeno(1,2,3-cd)pyrene	NS	NS	NS
Naphthalene	NS	NS	NS
Phenanthrene	0.37 J	0.5 J	0.33 U
Pyrene	0.33 U	0.79 J	0.33 U
VOC			
1,1,1-Trichloroethane	NS	NS	NS
cis-1,2-Dichloroethene	U	U	U
Tetrachloroethene	NS	NS	NS
Trichloroethene	0.034 J	0.015 J	0.01 J
Vinyl chloride	U	U	U

SP-6	1-2(ft BGS)	10-12(ft BGS)	16-18(ft BGS)
INORG			
Arsenic	1.9 J	6.3 J	2.5 J
Chromium Total	8.5 J [C]	13 J [C]	0.061 J
Copper	6.3 J	11 J	7.1 J
Cyanide (total)	NS	NS	NS
Lead	37 J	12 J	4.3 J
Mercury	0.1 U	0.1 U	0.1 U
Selenium	NS	NS	NS
PCB			
Total PCBs	U	U	U
SVOC			
Acenaphthene	NS	NS	NS
Anthracene	0.33 U	0.33 U	3.1 J
Benzo(a)anthracene	0.33 U	0.33 U	0.33 U
Benzo(a)pyrene	NS	NS	NS
Benzo(b)fluoranthene	NS	NS	NS
Benzo(g,h,i)perylene	NS	NS	NS
Benzo(k)fluoranthene	NS	NS	NS
Chrysene	0.33 U	0.33 U	0.56 J
Dibenzofuran	NS	NS	NS
Fluoranthene	0.33 U	0.33 U	4.3 J
Fluorene	NS	NS	NS
Indeno(1,2,3-cd)pyrene	NS	NS	NS
Naphthalene	NS	NS	NS
Phenanthrene	0.33 U	0.33 U	1.1 J
Pyrene	0.33 U	0.33 U	0.79 J
VOC			
1,1,1-Trichloroethane	NS	NS	NS
cis-1,2-Dichloroethene	U	U	U
Tetrachloroethene	NS	NS	NS
Trichloroethene	0.013 J	U	U
Vinyl chloride	U	U	U

SP-7-SB1	11-13(ft BGS)	17-19(ft BGS)
INORG		
Arsenic	3.9 J	3.4 J
Chromium Total	10 J [C]	20 J [C]
Copper	8.6 J	11 J
Cyanide (total)	NS	NS
Lead	11 J	13 J
Mercury	0.1 U	0.1 U
Selenium	NS	NS
PCB		
Total PCBs	U	U
SVOC		
Acenaphthene	NS	NS
Anthracene	0.33 U	0.33 U
Benzo(a)anthracene	0.33 U	0.33 U
Benzo(a)pyrene	NS	NS
Benzo(b)fluoranthene	NS	NS
Benzo(g,h,i)perylene	NS	NS
Benzo(k)fluoranthene	NS	NS
Chrysene	0.33 U	0.33 U
Dibenzofuran	NS	NS
Fluoranthene	0.33 U	0.33 U
Fluorene	NS	NS
Indeno(1,2,3-cd)pyrene	NS	NS
Naphthalene	NS	NS
Phenanthrene	0.33 U	0.33 U
Pyrene	0.33 U	0.33 U
VOC		
1,1,1-Trichloroethane	NS	NS
cis-1,2-Dichloroethene	0.34 J	0.028 J
Tetrachloroethene	NS	NS
Trichloroethene	0.88 J [AB]	0.072 J
Vinyl chloride	U	U

LEGEND:

FORMER BUILDING LOCATION
SB-13 — SOIL BORING–NO OIL IN SOIL AND/OR WATER OBSERVED
MW-P2A-3L — COMPLETED MONITORING WELL LOCATION – NO OIL IN SOIL AND/OR WATER OBSERVED
TW/SB-P9-2-3 — SOIL BORING WITH TEMPORARY WELL
POWER POLE
STORM MANHOLE
COVER PLATE
MANHOLE
POLE POST
LIGHT POST
POTENTIAL AREA OF INTEREST (PAOI)

NOTES/ACRONYMS:

- B – METHOD BLANK CONTAMINATION
- DCC – DIRECT CONTACT CRITERIA
- DWP – DRINKING WATER PROTECTION CRITERIA
- GSIP – GROUNDWATER SURFACE WATER INTERFACE PROTECTION
- GCCP – GROUNDWATER CONTACT CRITERIA PROTECTION
- INORG – INORGANICS
- J – ESTIMATED VALUE
- M – RESULT REPORTED TO MDL NOT RDL
- NS – NOT SAMPLED
- PCB – POLYCHLORINATED BIPHENYLS
- PSIC – PARTICULATE SOIL INHALATION CRITERIA
- S – SURROGATE RECOVERY OUTSIDE OF CONTROL LIMITS
- SVIIC – SOIL VOLATILIZATION TO INDOOR AIR INHALATION CRITERIA
- SVOCs – SEMI-VOLATILE ORGANIC COMPOUNDS
- U – NON-DETECT AT ASSOCIATED VALUE
- VOCs – VOLATILE ORGANIC COMPOUNDS
- VSIC – INFINITE SOURCE VOLATILE SOIL INHALATION CRITERIA
- X – ELEVATED REPORTING LIMIT DUE TO MATRIX INTERFERENCE
- Y – ELEVATED REPORTING LIMIT DUE TO HIGH TARGET CONCENTRATION

EXCEEDANCE CODES

- [A] – MDEQ Residential DWP
- [B] – MDEQ Industrial DWP
- [C] – MDEQ GSIP
- [D] – MDEQ Residential SVIIC
- [E] – MDEQ Industrial SVIIC
- [F] – MDEQ Residential VSIC
- [G] – MDEQ Industrial VSIC
- [H] – MDEQ Residential PSIC
- [I] – MDEQ Industrial PSIC
- [J] – MDEQ Residential DCC
- [K] – MDEQ Industrial DCC

NOTES:

1. SOIL CONCENTRATIONS ARE HIGHLIGHTED WHEN FACILITY-RELATED CONCENTRATIONS (SEE NOTE 2) ARE HIGHER THAN THE RESIDENTIAL OR INDUSTRIAL SCREENING LEVELS FOR DWP, GSIP, VSIC, PSIC, DC, AND THE RISK-BASED REDEVELOPMENT WORKER CONTACT.
2. ~~FACILITY-RELATED SOIL CONCENTRATIONS ARE THOSE IN EXCESS OF THE BACKGROUND LEVELS.~~ STATEWIDE DEFAULT BACKGROUND LEVELS PUBLISHED WITH PART 201 GENERIC CLEANUP CRITERIA AND SCREENING LEVELS ARE USED AS BACKGROUND LEVELS.

LOCATION — ANALYTE — DEPTH (FEET BELOW GROUND SURFACE) — VALIDATION CODE — EXCEEDANCE CODE — CONCENTRATION IN mg/kg — DUPLICATE SAMPLE CONCENTRATION IN mg/kg

MW-14SR	10-12(ft BGS)
INORG	
Chromium Total	75.7/93.2
Cyanide (total)	NS/NS
Lead	2080 J [MN]/6200 J [MN]

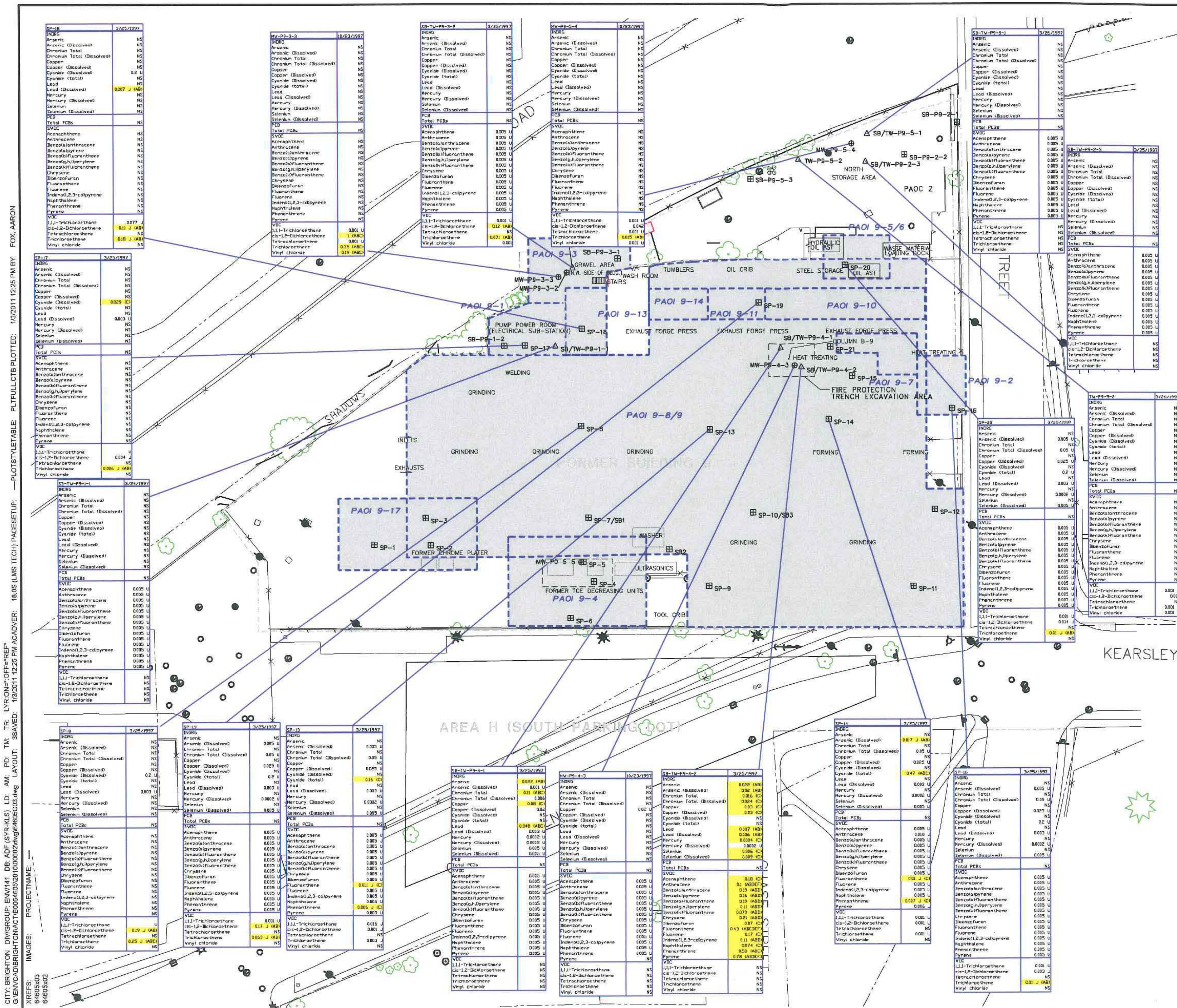
0 30' 60'
GRAPHIC SCALE

MOTORS LIQUIDATION COMPANY
FORMER BUILDING 9 DELPHI FLINT WEST FACILITY
FLINT, MICHIGAN
BUILDING 9 INVESTIGATION WORK PLAN

ANALYTES IN SOIL - SOUTHERN PORTION FORMER BUILDING 9 AREA DATABOX EXCEEDANCES MAP

ARCADIS

FIGURE
2



LEGEND:

- FORMER BUILDING LOCATION
- SB-13 — SOIL BORING–NO OIL IN SOIL AND/OR WATER OBSERVED
- MW-P2A-3L — COMPLETED MONITORING WELL LOCATION – NO OIL IN SOIL AND/OR WATER OBSERVED
- TW/SB-P9-2-3 — SOIL BORING WITH TEMPORARY WELL
- POWER POLE
- STORM MANHOLE
- COVER PLATE
- MANHOLE
- POLE POST
- LIGHT POST
- POTENTIAL AREA OF INTEREST (PAOI)

NOTES:

1. ALL CONCENTRATIONS IN mg/kg.
2. GROUNDWATER CONCENTRATIONS ARE HIGHLIGHTED WHEN THEY ARE HIGHER THAN THE RESIDENTIAL OR INDUSTRIAL SCREENING LEVELS FOR GWVIA, GCC, GSI, OR THE FOLLOWING MDEQ WATER QUALITY CRITERIA: AMV, FCV, WILDLIFE, DW CARCINOGEN, DW NON-CARCINOGEN, NON-DW CARCINOGEN, NON-DW NON-CARCINOGEN, AND FAV.

LOCATION — DATE SAMPLED

MW-TW-SB-P2A-4-1995	12/8/1995
INORG	
Arsenic	0.21 {ABCHK}/1.6 {ABCGHKMN}
Arsenic (Dissolved)	0.01 U/0.015 {AB}

ANALYTE; CONCENTRATION IN mg/L; EXCEEDANCE CODE; VALIDATION CODE; DUPLICATE SAMPLE CONCENTRATION IN mg/L

NOTES/ACRONYMS:

- AMV – AQUATIC LIFE MAXIMUM VALUE
- B – ESTIMATED VALUE (METALS)
- DW – DRINKING WATER
- FAV – FINAL ACUTE VALUE
- FCV – FINAL CHRONIC VALUE
- GCC – GROUNDWATER CONTACT CRITERIA
- GSI – GROUNDWATER SURFACE WATER INTERFACE PROTECTION
- GWVIA – GROUNDWATER VOLATILIZATION TO INDOOR AIR INHALATION CRITERIA
- INORG – INORGANICS
- J – ESTIMATED VALUE
- NS – NOT SAMPLED
- PCB – POLYCHLORINATED BIPHENYLS
- SVOCs – SEMI-VOLATILE ORGANIC COMPOUNDS
- U – NON-DETECT AT ASSOCIATED VALUES
- VOCs – VOLATILE ORGANIC COMPOUNDS
- [D] – DISSOLVED
- [T] – TOTAL

EXCEEDANCE CODES

- {A} – MDEQ RESIDENTIAL DW
- {B} – MDEQ INDUSTRIAL DW
- {C} – MDEQ GSI
- {D} – MDEQ GCC
- {E} – MDEQ RESIDENTIAL GWVIA
- {F} – MDEQ INDUSTRIAL GWVIA
- {G} – MDEQ AMBIENT WATER QUALITY AMV
- {H} – MDEQ AMBIENT WATER QUALITY FCV
- {I} – MDEQ AMBIENT WATER QUALITY WILDLIFE
- {J} – MDEQ AMBIENT WATER QUALITY DW CARCINOGEN
- {K} – MDEQ AMBIENT WATER QUALITY DW NON-CARCINOGEN
- {L} – MDEQ AMBIENT WATER QUALITY NON-DW CARCINOGEN
- {M} – MDEQ AMBIENT WATER QUALITY NON-DW NON-CARCINOGEN
- {N} – MDEQ AMBIENT WATER QUALITY FAV

0 30' 60'
GRAPHIC SCALE

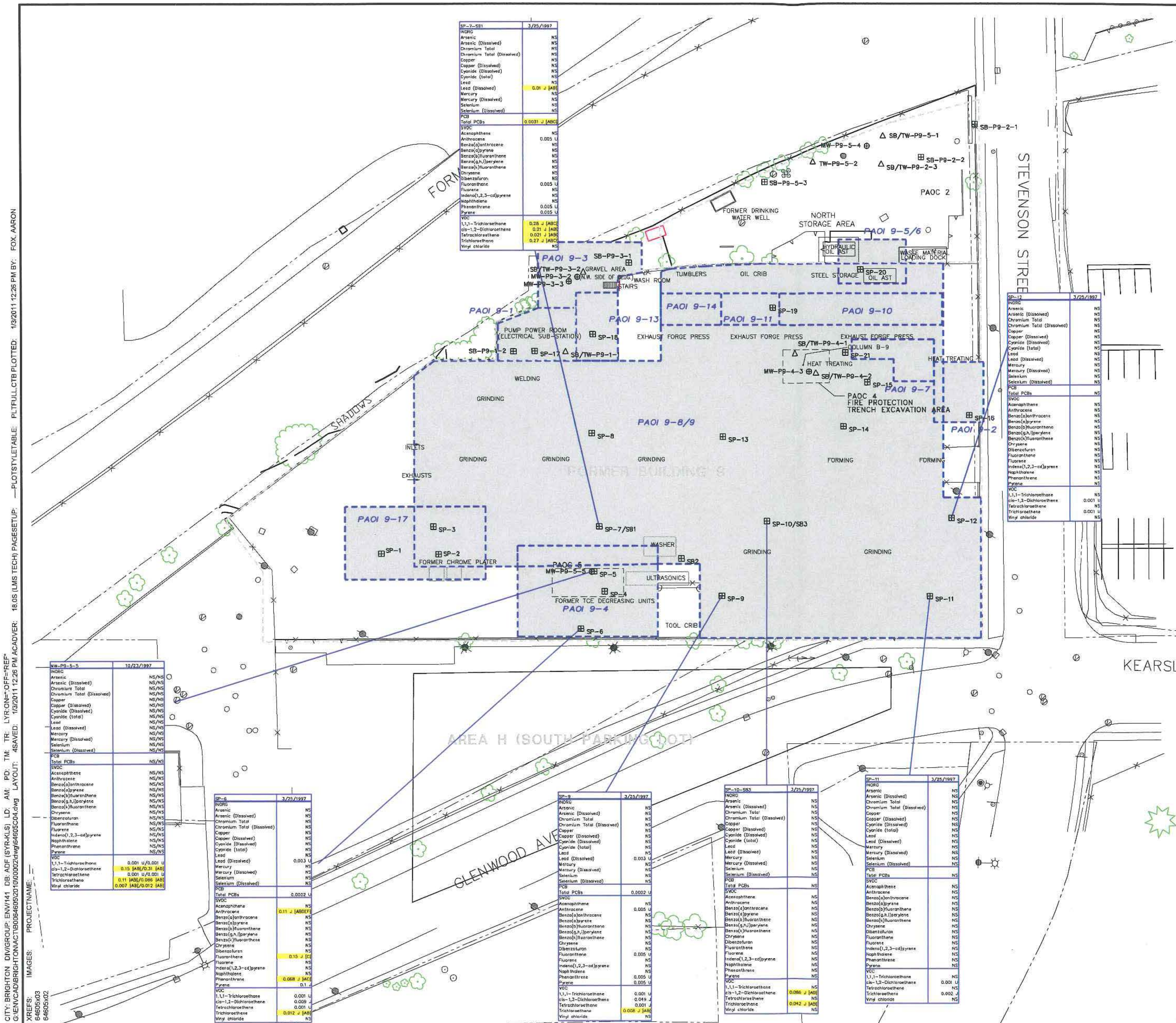
MOTORS LIQUIDATION COMPANY
FORMER BUILDING 9 DELPHI FLINT WEST FACILITY
FLINT, MICHIGAN
BUILDING 9 INVESTIGATION WORK PLAN

ANALYTES IN GROUNDWATER - NORTHERN PORTION OF FORMER BUILDING 9 AREA DATABOX EXCEEDANCES MAP

ARCADIS

FIGURE 3

CITY: BRIGHTON DIV/GROUP: ENV/141 DB: ADF (SYR-KLS) LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\ENVCAD\BRIGHTON\ACT\B0064605\0010\00002\dwg\64605C03.dwg LAYOUT: 3SAVED: 1/3/2011 12:25 PM ACADVER: 18.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 1/3/2011 12:25 PM BY: FOX, AARON
XREFS: 64605x03 64605x02 IMAGES: PROJECTNAME: ----



LEGEND:

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- SB-13 — SOIL BORING–NO OIL IN SOIL AND/OR WATER OBSERVED
- MW-P2A-3L — COMPLETED MONITORING WELL LOCATION – NO OIL IN SOIL AND/OR WATER OBSERVED
- TW/SB-P9-2-3 — SOIL BORING WITH TEMPORARY WELL
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- COVER PLATE
- MANHOLE
- POLE POST
- LIGHT POST
- POTENTIAL AREA OF INTEREST (PAOI)

NOTES:

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LOCATION — DATE SAMPLED

MW-TW-SB-P2A-4-1995	12/8/1995
INORG	
Arsenic	0.21 {ABCHK}/1.6 {ABCGHKMN}
Arsenic (Dissolved)	0.01 U/0.015 [AB]

ANALYTE; CONCENTRATION IN mg/L; EXCEEDANCE CODE; VALIDATION CODE; DUPLICATE SAMPLE CONCENTRATION IN mg/L

NOTES/ACRONYMS:

- AMV – AQUATIC LIFE MAXIMUM VALUE
- B – ESTIMATED VALUE (METALS)
- DWP – DRINKING WATER PROTECTION
- GCC – GROUNDWATER CONTACT CRITERIA
- GSI – GROUNDWATER SURFACE WATER INTERFACE PROTECTION
- GVIIC – GROUNDWATER VOLATILIZATION TO INDOOR AIR INHALATION CRITERIA
- INORG – INORGANICS
- J – ESTIMATED VALUE
- NS – NOT SAMPLED
- PCB – POLYCHLORINATED BIPHENYLS
- SVOCs – SEMI-VOLATILE ORGANIC COMPOUNDS
- U – NON-DETECT AT ASSOCIATED VALUES
- VOCs – VOLATILE ORGANIC COMPOUNDS
- [D] – DISSOLVED
- [T] – TOTAL

EXCEEDANCE CODES

- {A} – MDEQ Residential DWP
- {B} – MDEQ Industrial DWP
- {C} – MDEQ GSI
- {D} – MDEQ GCC
- {E} – MDEQ Residential GVIIC
- {F} – MDEQ Industrial GVIIC

MOTORS LIQUIDATION COMPANY
FORMER BUILDING 9 DELPHI FLINT WEST FACILITY
FLINT, MICHIGAN

BUILDING 9 INVESTIGATION WORK PLAN

ANALYTES IN GROUNDWATER - SOUTHERN PORTION OF FORMER BUILDING 9 AREA DATABOX EXCEEDANCES MAP

ARCADIS

FIGURE 4

CITY: BRIGHTON DIV/GROUP: ENV/141 DB: ADF (SYR-KLS) LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF* G:\ENVCAD\BRIGHTON\ACT\B0064605\0010\00002\dwg\64605C04.dwg LAYOUT: 4SAVED: 1/3/2011 12:26 PM ACADVER: 18.0S (LMS TECH) PAGESETUP: —PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 1/3/2011 12:26 PM BY: FOX, AARON
XREFS: IMAGES: PROJECTNAME: —
64605x03
64605x02

APPENDIX B

ARCADIS

Appendix B

Historic Analytical Data

Location ID: Date Collected:	Units	C3DC	C3DC-SDBL	C4DC	C4DC-SDBL	CSAT	CSAT-SDBL	GCCP	GCCP-SDBL	GSIP	GSIP-SDBL	IDC	IDC-SDBL	IDWP	IDWP-SDBL	IPSIC	IPSIC-SDBL	ISVIA
Detected VOCs																		
Benzene	mg/kg	400 {I,C}	400 {I,C}	400 {I,C}	400 {I,C}	400 {I}	400 {I}	220 {I}	220 {I}	4 {I,X}	4 {I,X}	400 {I,C}	400 {I,C}	0.1 {I}	0.1 {I}	470,000 {I}	470,000 {I}	8.4 {I}
cis-1,2-Dichloroethene	mg/kg	640 {C}	640 {C}	640 {C}	640 {C}	640	640	640 {C}	640 {C}	12	12	640 {C}	640 {C}	1.4	1.4	1,000,000	1,000,000	41
Ethylbenzene	mg/kg	140 {I,C}	140 {I,C}	140 {I,C}	140 {I,C}	140 {I}	140 {I}	140 {I,C}	140 {I,C}	0.36 {I}	0.36 {I}	140 {I,C}	140 {I,C}	1.5 {I}	1.5 {I}	13,000,000 {I}	13,000,000 {I}	140 {I,C}
Toluene	mg/kg	250 {I,C}	250 {I,C}	250 {I,C}	250 {I,C}	250 {I}	250 {I}	250 {I,C}	250 {I,C}	2.8 {I}	2.8 {I}	250 {I,C}	250 {I,C}	16 {I}	16 {I}	12,000,000 {I}	12,000,000 {I}	250 {I,C}
trans-1,2-Dichloroethene	mg/kg	1,400 {C}	1,400 {C}	1,400 {C}	1,400 {C}	1,400	1,400	1,400 {C}	1,400 {C}	30	30	1,400 {C}	1,400 {C}	2	2	2,100,000	2,100,000	43
Trichloroethene	mg/kg	500 {C,DD}	500 {C,DD}	500 {C,DD}	500 {C,DD}	500	500	440	440	4 {X}	4 {X}	500 {C,DD}	500 {C,DD}	0.1	0.1	2,300,000	2,300,000	37
Vinyl chloride	mg/kg	47	47	40	40	490	490	20	20	0.3	0.3	34	34	0.04	0.04	890,000	890,000	2.8
Xylene (total)	mg/kg	150 {I,C}	150 {I,C}	150 {I,C}	150 {I,C}	150 {I}	150 {I}	150 {I,C}	150 {I,C}	0.7 {I}	0.7 {I}	150 {I,C}	150 {I,C}	5.6 {I}	5.6 {I}	130,000,000 {I}	130,000,000 {I}	150 {I,C}
Detected SVOCs																		
2-Methylnaphthalene	mg/kg	37,000	37,000	31,000	31,000	{NA}	{NA}	5,500	5,500	{ID}	{ID}	26,000	26,000	170	170	{ID}	{ID}	{ID}
Acenaphthene	mg/kg	180,000	180,000	150,000	150,000	{NA}	{NA}	970	970	4.4	4.4	130,000	130,000	880	880	6,200,000	6,200,000	350,000
Anthracene	mg/kg	1,000,000	1,000,000	860,000	860,000	{NA}	{NA}	41	41	{ID}	{ID}	730,000	730,000	41	41	29,000,000	29,000,000	1,000,000 {D}
Benzo(a)anthracene	mg/kg	160 {Q}	160 {Q}	110 {Q}	110 {Q}	{NA}	{NA}	{NLL}	{NLL}	{NLL}	{NLL}	80 {Q}	80 {Q}	{NLL}	{NLL}	{ID}	{ID}	{NLV}
Benzo(a)pyrene	mg/kg	16 {Q}	16 {Q}	11 {Q}	11 {Q}	{NA}	{NA}	{NLL}	{NLL}	{NLL}	{NLL}	8 {Q}	8 {Q}	{NLL}	{NLL}	1,900 {Q}	1,900 {Q}	{NLV}
Benzo(b)fluoranthene	mg/kg	160 {Q}	160 {Q}	110 {Q}	110 {Q}	{NA}	{NA}	{NLL}	{NLL}	{NLL}	{NLL}	80 {Q}	80 {Q}	{NLL}	{NLL}	{ID}	{ID}	{ID}
Benzo(g,h,i)perylene	mg/kg	14,000	14,000	9,500	9,500	{NA}	{NA}	{NLL}	{NLL}	{NLL}	{NLL}	7,000	7,000	{NLL}	{NLL}	350,000	350,000	{NLV}
Benzo(k)fluoranthene	mg/kg	1,600 {Q}	1,600 {Q}	1,100 {Q}	1,100 {Q}	{NA}	{NA}	{NLL}	{NLL}	{NLL}	{NLL}	800 {Q}	800 {Q}	{NLL}	{NLL}	{ID}	{ID}	{NLV}
Butyl benzylphthalate	mg/kg	310 {C}	310 {C}	310 {C}	310 {C}	310	310	310 {C}	310 {C}	26 {X}	26 {X}	310 {C}	310 {C}	310 {C}	310 {C}	21,000,000	21,000,000	{NLV}
Chrysene	mg/kg	16,000 {Q}	16,000 {Q}	11,000 {Q}	11,000 {Q}	{NA}	{NA}	{NLL}	{NLL}	{NLL}	{NLL}	8,000 {Q}	8,000 {Q}	{NLL}	{NLL}	{ID}	{ID}	{ID}
Dibenz(a,h)anthracene	mg/kg	16 {Q}	16 {Q}	11 {Q}	11 {Q}	{NA}	{NA}	{NLL}	{NLL}	{NLL}	{NLL}	8 {Q}	8 {Q}	{NLL}	{NLL}	{ID}	{ID}	{NLV}
Dibenzofuran	mg/kg	{ID}	{ID}	{ID}	{ID}	{NA}	{NA}	{ID}	{ID}	1.7	1.7	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}
Di-n-butylphthalate	mg/kg	760 {C}	760 {C}	760 {C}	760 {C}	760	760	760 {C}	760 {C}	11	11	760 {C}	760 {C}	760 {C}	760 {C}	1,500,000	1,500,000	{NLV}
Di-n-octyl phthalate	mg/kg	36,000	36,000	26,000	26,000	140,000	140,000	140,000 {C}	140,000 {C}	{ID}	{ID}	20,000	20,000	140,000 {C}	140,000 {C}	{ID}	{ID}	{NLV}
Fluoranthene	mg/kg	240,000	240,000	170,000	170,000	{NA}	{NA}	730	730	5.5	5.5	130,000	130,000	730	730	4,100,000	4,100,000	1,000,000 {D}
Fluorene	mg/kg	120,000	120,000	100,000	100,000	{NA}	{NA}	890	890	5.3	5.3	87,000	87,000	890	890	4,100,000	4,100,000	1,000,000 {D}
Indeno(1,2,3-cd)pyrene	mg/kg	160 {Q}	160 {Q}	110 {Q}	110 {Q}	{NA}	{NA}	{NLL}	{NLL}	{NLL}	{NLL}	80 {Q}	80 {Q}	{NLL}	{NLL}	{ID}	{ID}	{NLV}
Naphthalene	mg/kg	72,000	72,000	61,000	61,000	{NA}	{NA}	2,100	2,100	0.87	0.87	52,000	52,000	100	100	88,000	88,000	470
Phenanthrene	mg/kg	7,200	7,200	6,100	6,100	{NA}	{NA}	1,100	1,100	5.3	5.3	5,200	5,200	160	160	2,900	2,900	5,100
Pyrene	mg/kg	150,000	150,000	110,000	110,000	{NA}	{NA}	480	480	{ID}	{ID}	84,000	84,000	480	480	2,900,000	2,900,000	1,000,000 {D}
Detected PCBs																		
Total PCBs	mg/kg	33 {J,T}	33 {J,T}	22 {J,T}	22 {J,T}	{NA}	{NA}	{NLL}	{NLL}	{NLL}	{NLL}	16 {J,T}	16 {J,T}	{NLL}	{NLL}	6,500 {J,T}	6,500 {J,T}	16,000 {J,T}
Detected Inorganics																		
Arsenic	mg/kg	46	46	41	41	{NA}	{NA}	2,000	2,000	70 {X}	70 {X}	37	37	23	23	910	910	{NLV}
Barium	mg/kg	150,000 {B}	150,000 {B}	140,000 {B}	140,000 {B}	{NA}	{NA}	1,000,000 {B,D}	1,000,000 {B,D}	858 {B,G,X}	858 {B,G,X}	130,000 {B}	130,000 {B}	1,300 {B}	1,300 {B}	150,000 {B}	150,000 {B}	{NLV}
Cadmium	mg/kg	2,100 {B}	2,100 {B}	2,100 {B}	2,100 {B}	{NA}	{NA}	230,000 {B}	230,000 {B}	5.74 {B,G,X}	5.74 {B,G,X}	2,100 {B}	2,100 {B}	6 {B}	6 {B}	2,200 {B}	2,200 {B}	{NLV}
Chromium Total	mg/kg	10,000	10,000	9,600	9,600	{NA}	{NA}	140,000	140,000	3.3	18 {SDBL}	9,200	9,200	30	30	240	240	{NLV}
Copper	mg/kg	79,000 {B}	79,000 {B}	76,000 {B}	76,000 {B}	{NA}	{NA}	1,000,000 {B,D}	1,000,000 {B,D}	124 {B,G}	124 {B,G}	73,000 {B}	73,000 {B}	5,800 {B}	5,800 {B}	59,000 {B}	59,000 {B}	{NLV}
Lead	mg/kg	400 {B}	400 {B}	400 {B}	400 {B}	{NA}	{NA}	{ID}	{ID}	5,450 {B,G,X}	5,450 {B,G,X}	900 {B,DD}	900 {B,DD}	700 {B}	700 {B}	44,000 {B}	44,000 {B}	{NLV}
Mercury	mg/kg	620 {B,Z}	620 {B,Z}	600 {B,Z}	600 {B,Z}	{NA}	{NA}	47 {B,Z}	47 {B,Z}	0.05 {B,Z,M}	0.13 {SDBL}	580 {B,Z}	580 {B,Z}	1.7 {B,Z}	1.7 {B,Z}	8,800 {B,Z}	8,800 {B,Z}	89 {B,Z}
Nickel	mg/kg	160,000 {B}	160,000 {B}	150,000 {B}	150,000 {B}	{NA}	{NA}	1,000,000 {B,D}	1,000,000 {B,D}	129 {B,G}	129 {B,G}	150,000 {B}	150,000 {B}	100 {B}	100 {B}	16,000 {B}	16,000 {B}	{NLV}
Selenium	mg/kg	10,000 {B}	10,000 {B}	10,000 {B}	10,000 {B}	{NA}	{NA}	78,000 {B}	78,000 {B}	0.4 {B}	0.41 {SDBL}	9,600 {B}	9,600 {B}	4 {B}	4 {B}	59,000 {B}	59,000 {B}	{NLV}
Zinc	mg/kg	690,000 {B}	690,000 {B}	660,000 {B}	660,000 {B}	{NA}	{NA}	1,000,000 {B,D}	1,000,000 {B,D}	280 {B,G}	280 {B,G}	630,000 {B}	630,000 {B}	5,000 {B}	5,000 {B}	{ID}	{ID}	{NLV}

Location ID: Date Collected:	Units	ISVIA-SDBL	IVSIC2	IVSIC2-SDBL	IVSIC5	IVSIC5-SDBL	IVSICI	IVSICI-SDBL	RDC	RDC-SDBL	RDWP	RDWP-SDBL	RPSIC	RPSIC-SDBL	RSVIA	RSVIA-SDBL	RVSIC2	RVSIC2-SDBL
Detected VOCs																		
Benzene	mg/kg	8.4 {I}	230 {I}	230 {I}	99 {I}	99 {I}	45 {I}	45 {I}	180 {I}	180 {I}	0.1 {I}	0.1 {I}	380,000 {I}	380,000 {I}	1.6 {I}	1.6 {I}	79 {I}	79 {I}
cis-1,2-Dichloroethene	mg/kg	41	1,000	1,000	430	430	210	210	640 {C}	640 {C}	1.4	1.4	2,300,000	2,300,000	22	22	990	990
Ethylbenzene	mg/kg	140 {I,C}	6,500 {I}	6,500 {I}	3,100 {I}	3,100 {I}	2,400 {I}	2,400 {I}	140 {I,C}	140 {I,C}	1.5 {I}	1.5 {I}	10,000,000 {I}	10,000,000 {I}	87 {I}	87 {I}	2,200 {I}	2,200 {I}
Toluene	mg/kg	250 {I,C}	36,000 {I}	36,000 {I}	36,000 {I}	36,000 {I}	3,300 {I}	3,300 {I}	250 {I,C}	250 {I,C}	16 {I}	16 {I}	27,000,000 {I}	27,000,000 {I}	250 {I,C}	250 {I,C}	12,000 {I}	12,000 {I}
trans-1,2-Dichloroethene	mg/kg	43	2,000	2,000	840	840	330	330	1,400 {C}	1,400 {C}	2	2	4,700,000	4,700,000	23	23	2,000	2,000
Trichloroethene	mg/kg	37	1,100	1,100	440	440	260	260	500 {C,DD}	500 {C,DD}	0.1	0.1	1,800,000	1,800,000	7.1	7.1	390	390
Vinyl chloride	mg/kg	2.8	420	420	170	170	29	29	3.8	3.8	0.04	0.04	350,000	350,000	0.27	0.27	73	73
Xylene (total)	mg/kg	150 {I,C}	130,000 {I}	130,000 {I}	65,000 {I}	65,000 {I}	54,000 {I}	54,000 {I}	150 {I,C}	150 {I,C}	5.6 {I}	5.6 {I}	290,000,000 {I}	290,000,000 {I}	150 {I,C}	150 {I,C}	130,000 {I}	130,000 {I}
Detected SVOCs																		
2-Methylnaphthalene	mg/kg	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	8,100	8,100	57	57	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}
Acenaphthene	mg/kg	350,000	97,000	97,000	97,000	97,000	97,000	97,000	41,000	41,000	300	300	14,000,000	14,000,000	190,000	190,000	81,000	81,000
Anthracene	mg/kg	1,000,000 {D}	1,600,000	1,600,000	1,600,000	1,600,000	1,600,000	1,600,000	230,000	230,000	41	41	67,000,000	67,000,000	1,000,000 {D}	1,000,000 {D}	1,400,000	1,400,000
Benzo(a)anthracene	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	20 {Q}	20 {Q}	{NLL}	{NLL}	{ID}	{ID}	{NLV}	{NLV}	{NLV}	{NLV}
Benzo(a)pyrene	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	2 {Q}	2 {Q}	{NLL}	{NLL}	1,500 {Q}	1,500 {Q}	{NLV}	{NLV}	{NLV}	{NLV}
Benzo(b)fluoranthene	mg/kg	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	20 {Q}	20 {Q}	{NLL}	{NLL}	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}
Benzo(g,h,i)perylene	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	2,500	2,500	{NLL}	{NLL}	800,000	800,000	{NLV}	{NLV}	{NLV}	{NLV}
Benzo(k)fluoranthene	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	200 {Q}	200 {Q}	{NLL}	{NLL}	{ID}	{ID}	{NLV}	{NLV}	{NLV}	{NLV}
Butyl benzylphthalate	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	310 {C}	310 {C}	310 {C}	310 {C}	47,000,000	47,000,000	{NLV}	{NLV}	{NLV}	{NLV}
Chrysene	mg/kg	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	2,000 {Q}	2,000 {Q}	{NLL}	{NLL}	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}
Dibenz(a,h)anthracene	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	2 {Q}	2 {Q}	{NLL}	{NLL}	{ID}	{ID}	{NLV}	{NLV}	{NLV}	{NLV}
Dibenzofuran	mg/kg	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}	{ID}
Di-n-butylphthalate	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	760 {C}	760 {C}	760 {C}	760 {C}	3,300,000	3,300,000	{NLV}	{NLV}	{NLV}	{NLV}
Di-n-octyl phthalate	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	6,900	6,900	100,000	100,000	{ID}	{ID}	{NLV}	{NLV}	{NLV}	{NLV}
Fluoranthene	mg/kg	1,000,000 {D}	880,000	880,000	880,000	880,000	890,000	890,000	46,000	46,000	730	730	9,300,000	9,300,000	1,000,000 {D}	1,000,000 {D}	740,000	740,000
Fluorene	mg/kg	1,000,000 {D}	150,000	150,000	150,000	150,000	150,000	150,000	27,000	27,000	390	390	9,300,000	9,300,000	580,000	580,000	130,000	130,000
Indeno(1,2,3-cd)pyrene	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	20 {Q}	20 {Q}	{NLL}	{NLL}	{ID}	{ID}	{NLV}	{NLV}	{NLV}	{NLV}
Naphthalene	mg/kg	470	350	350	350	350	350	350	16,000	16,000	35	35	200,000	200,000	250	250	300	300
Phenanthrene	mg/kg	5,100	190	190	190	190	190	190	1,600	1,600	56	56	6,700	6,700	2,800	2,800	160	160
Pyrene	mg/kg	1,000,000 {D}	780,000	780,000	780,000	780,000	780,000	780,000	29,000	29,000	480	480	6,700,000	6,700,000	1,000,000 {D}	1,000,000 {D}	650,000	650,000
Detected PCBs																		
Total PCBs	mg/kg	16,000 {J,T}	28,000 {J,T}	28,000 {J,T}	28,000 {J,T}	28,000 {J,T}	810 {J,T}	810 {J,T}	4 {J,T}	4 {J,T}	{NLL}	{NLL}	5,200 {J,T}	5,200 {J,T}	3,000 {J,T}	3,000 {J,T}	7,900 {J,T}	7,900 {J,T}
Detected Inorganics																		
Arsenic	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	7.6	7.6	23	23	720	720	{NLV}	{NLV}	{NLV}	{NLV}
Barium	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	37,000 {B}	37,000 {B}	1,300 {B}	1,300 {B}	330,000 {B}	330,000 {B}	{NLV}	{NLV}	{NLV}	{NLV}
Cadmium	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	550 {B}	550 {B}	6 {B}	6 {B}	1,700 {B}	1,700 {B}	{NLV}	{NLV}	{NLV}	{NLV}
Chromium Total	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	2,500	2,500	30	30	260	260	{NLV}	{NLV}	{NLV}	{NLV}
Copper	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	20,000 {B}	20,000 {B}	5,800 {B}	5,800 {B}	130,000 {B}	130,000 {B}	{NLV}	{NLV}	{NLV}	{NLV}
Lead	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	400 {B}	400 {B}	700 {B}	700 {B}	100,000 {B}	100,000 {B}	{NLV}	{NLV}	{NLV}	{NLV}
Mercury	mg/kg	89 {B,Z}	62 {B,Z}	62 {B,Z}	62 {B,Z}	62 {B,Z}	62 {B,Z}	62 {B,Z}	160 {B,Z}	160 {B,Z}	1.7 {B,Z}	1.7 {B,Z}	20,000 {B,Z}	20,000 {B,Z}	48 {B,Z}	48 {B,Z}	52 {B,Z}	52 {B,Z}
Nickel	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	40,000 {B}	40,000 {B}	100 {B}	100 {B}	13,000 {B}	13,000 {B}	{NLV}	{NLV}	{NLV}	{NLV}
Selenium	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	2,600 {B}	2,600 {B}	4 {B}	4 {B}	130,000 {B}	130,000 {B}	{NLV}	{NLV}	{NLV}	{NLV}
Zinc	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	{NLV}	170,000 {B}	170,000 {B}	2,400 {B}	2,400 {B}	{ID}	{ID}	{NLV}	{NLV}	{NLV}	{NLV}

Historic Analytical Soil Data
Flint West, Building 9

Location ID: Date Collected:	Units	RVSIC5	RVSIC5-SDBL	RVSICI	RVSICI-SDBL	SDBL	SB/TW-P9-1-1 03/24/97	SB/TW-P9-1-1 03/24/97	SB/TW-P9-2-3 03/25/97	SB/TW-P9-2-3 03/25/97	SB/TW-P9-3-2 03/25/97	SB/TW-P9-3-2 03/25/97	SB/TW-P9-3-2 03/25/97	SB/TW-P9-4-1 03/24/97
Detected VOCs														
Benzene	mg/kg	34 {I}	34 {I}	13 {I}	13 {I}	{NA}	NA	NA	NA	NA	NA	NA	ND(0.01)	NA
cis-1,2-Dichloroethene	mg/kg	420	420	180	180	{NA}	NA	NA	NA	NA	NA	NA	ND(0.01)	NA
Ethylbenzene	mg/kg	1,000 {I}	1,000 {I}	720 {I}	720 {I}	{NA}	NA	NA	NA	NA	NA	NA	ND(0.01)	NA
Toluene	mg/kg	5,100 {I}	5,100 {I}	2,800 {I}	2,800 {I}	{NA}	NA	NA	NA	NA	NA	NA	ND(0.01)	NA
trans-1,2-Dichloroethene	mg/kg	830	830	280	280	{NA}	NA	NA	NA	NA	NA	NA	ND(0.01)	NA
Trichloroethene	mg/kg	170	170	78	78	{NA}	NA	NA	NA	NA	NA	NA	ND(0.01)	NA
Vinyl chloride	mg/kg	30	30	4.2	4.2	{NA}	NA	NA	NA	NA	NA	NA	ND(0.01)	NA
Xylene (total)	mg/kg	61,000 {I}	61,000 {I}	46,000 {I}	46,000 {I}	{NA}	NA	NA	NA	NA	NA	NA	ND(0.03)	NA
Detected SVOCs														
2-Methylnaphthalene	mg/kg	{ID}	{ID}	{ID}	{ID}	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	ND(0.33)
Acenaphthene	mg/kg	81,000	81,000	81,000	81,000	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	ND(0.33)
Anthracene	mg/kg	1,400,000	1,400,000	1,400,000	1,400,000	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	ND(0.33)
Benzo(a)anthracene	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	ND(0.33)
Benzo(a)pyrene	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	ND(0.33)
Benzo(b)fluoranthene	mg/kg	{ID}	{ID}	{ID}	{ID}	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	ND(0.33)
Benzo(g,h,i)perylene	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	ND(0.33)
Benzo(k)fluoranthene	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	ND(0.33)
Butyl benzylphthalate	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	ND(0.33)
Chrysene	mg/kg	{ID}	{ID}	{ID}	{ID}	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	0.98
Dibenz(a,h)anthracene	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	ND(0.33)
Dibenzofuran	mg/kg	{ID}	{ID}	{ID}	{ID}	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	ND(0.33)
Di-n-butylphthalate	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	ND(0.33)
Di-n-octyl phthalate	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	ND(0.33)
Fluoranthene	mg/kg	740,000	740,000	740,000	740,000	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	ND(0.33)
Fluorene	mg/kg	130,000	130,000	130,000	130,000	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	0.8
Indeno(1,2,3-cd)pyrene	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	ND(0.33)
Naphthalene	mg/kg	300	300	300	300	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	ND(0.33)
Phenanthrene	mg/kg	160	160	160	160	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	2.2
Pyrene	mg/kg	650,000	650,000	650,000	650,000	{NA}	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	0.45
Detected PCBs														
Total PCBs	mg/kg	7,900 {J,T}	7,900 {J,T}	240 {J,T}	240 {J,T}	{NA}	NA	NA	NA	NA	NA	NA	NA	NA
Detected Inorganics														
Arsenic	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	5.8	NA	3.1	NA	5.8	NA	NA	NA	4.7
Barium	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	75 {B}	NA	13	NA	37	NA	NA	NA	30
Cadmium	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	1.2 {B}	NA	ND(0.05)	NA	0.14	NA	NA	NA	0.16
Chromium Total	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	18 {B,H}	NA	5 (GSIP)	NA	13 (GSIP)	NA	NA	NA	7.4 (GSIP)
Copper	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	32 {B}	NA	3.8	NA	9.1	NA	NA	NA	7
Lead	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	21 {B}	NA	2.8	NA	6.2	NA	NA	NA	4.7
Mercury	mg/kg	52 {B,Z}	52 {B,Z}	52 {B,Z}	52 {B,Z}	0.13 {B,Z}	NA	0.18 (GSIP,GSIP-SDBL,SDBL)	NA	ND(0.1)	NA	NA	NA	ND(0.1)
Nickel	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	20 {B}	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	mg/kg	{NLV}	{NLV}	{NLV}	{NLV}	0.41 {B}	NA	ND(0.5)	NA	0.51 (GSIP,GSIP-SDBL,SDBL)	NA	NA	NA	0.7 (GSIP,GSIP-SDBL,SDBL)
Zinc	mg/kg	{NLV}	{NLV}	{B}	{B}	47 {B}	NA	8.9	NA	26	NA	NA	NA	46

Historic Analytical Soil Data
Flint West, Building 9

Location ID:		SB/TW-P9-4-1	SB/TW-P9-4-2	SB/TW-P9-4-2	SB/TW-P9-5-1	SB-P9-1-2	SB-P9-1-2	SB-P9-2-1	SB-P9-2-1	SB-P9-2-2	SB-P9-2-2	SB-P9-3-1	SB-P9-3-1
Date Collected:	Units	03/24/97	03/25/97	03/25/97	03/26/97	03/24/97	03/24/97	03/25/97	03/25/97	03/25/97	03/25/97	03/25/97	03/25/97
Detected VOCs													
Benzene	mg/kg	NA	NA	NA	ND(0.01)	NA	NA	NA	NA	NA	NA	NA	ND(0.01)
cis-1,2-Dichloroethene	mg/kg	NA	NA	NA	ND(0.01)	NA	NA	NA	NA	NA	NA	NA	0.18
Ethylbenzene	mg/kg	NA	NA	NA	ND(0.01)	NA	NA	NA	NA	NA	NA	NA	ND(0.01)
Toluene	mg/kg	NA	NA	NA	ND(0.01)	NA	NA	NA	NA	NA	NA	NA	ND(0.01)
trans-1,2-Dichloroethene	mg/kg	NA	NA	NA	ND(0.01)	NA	NA	NA	NA	NA	NA	NA	ND(0.01)
Trichloroethene	mg/kg	NA	NA	NA	ND(0.01)	NA	NA	NA	NA	NA	NA	NA	0.67 (IDWP,IDWP-SDBL,RDWP,RDWP-SDBL)
Vinyl chloride	mg/kg	NA	NA	NA	ND(0.01)	NA	NA	NA	NA	NA	NA	NA	ND(0.01)
Xylene (total)	mg/kg	NA	NA	NA	ND(0.03)	NA	NA	NA	NA	NA	NA	NA	ND(0.03)
Detected SVOCs													
2-Methylnaphthalene	mg/kg	4.1	ND(0.33)	0.68	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Acenaphthene	mg/kg	ND(1.32)	ND(0.33)	3.2	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Anthracene	mg/kg	ND(1.32)	ND(0.33)	1.3	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Benzo(a)anthracene	mg/kg	ND(1.32)	ND(0.33)	3.3	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Benzo(a)pyrene	mg/kg	ND(1.32)	ND(0.33)	4 (RDC,RDC-SDBL)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Benzo(b)fluoranthene	mg/kg	ND(1.32)	ND(0.33)	4	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Benzo(g,h,i)perylene	mg/kg	ND(1.32)	ND(0.33)	3.4	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Benzo(k)fluoranthene	mg/kg	ND(1.32)	ND(0.33)	2.8	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Butyl benzylphthalate	mg/kg	ND(1.32)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Chrysene	mg/kg	3.5	ND(0.33)	4.2	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	8	ND(0.33)
Dibenz(a,h)anthracene	mg/kg	ND(1.32)	ND(0.33)	0.69	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Dibenzofuran	mg/kg	ND(1.32)	ND(0.33)	1.1	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Di-n-butylphthalate	mg/kg	ND(1.32)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Di-n-octyl phthalate	mg/kg	ND(1.32)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Fluoranthene	mg/kg	3.9	ND(0.33)	7.2 (GSIP,GSIP-SDBL)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	1.1	ND(0.33)
Fluorene	mg/kg	6.3 (GSIP,GSIP-SDBL)	ND(0.33)	2.6	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	0.52	ND(0.33)
Indeno(1,2,3-cd)pyrene	mg/kg	ND(1.32)	ND(0.33)	3.1	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Naphthalene	mg/kg	3.2 (GSIP,GSIP-SDBL)	ND(0.33)	1.5 (GSIP,GSIP-SDBL)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Phenanthrene	mg/kg	23 (GSIP,GSIP-SDBL)	ND(0.33)	9.5 (GSIP,GSIP-SDBL)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	2.6	ND(0.33)
Pyrene	mg/kg	5.8	ND(0.33)	18	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	2.1	ND(0.33)
Detected PCBs													
Total PCBs	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Detected Inorganics													
Arsenic	mg/kg	8.5 (RDC,RDC-SDBL,SDBL)	8.8 (RDC,RDC-SDBL,SDBL)	1.3	NA	NA	NA	NA	NA	NA	NA	NA	12 (RDC,RDC-SDBL,SDBL)
Barium	mg/kg	40	41	6.6	NA	NA	NA	NA	NA	NA	NA	NA	89 (SDBL)
Cadmium	mg/kg	0.11	0.16	ND(0.05)	NA	NA	NA	NA	NA	NA	NA	NA	0.3
Chromium Total	mg/kg	14 (GSIP)	19 (GSIP,GSIP-SDBL,SDBL)	4.3 (GSIP)	NA	NA	NA	NA	NA	NA	NA	NA	28 (GSIP,GSIP-SDBL,SDBL)
Copper	mg/kg	10	11	2.4	NA	NA	NA	NA	NA	NA	NA	NA	19
Lead	mg/kg	7.2	10	1.7	NA	NA	NA	NA	NA	NA	NA	NA	13
Mercury	mg/kg	ND(0.1)	ND(0.1)	ND(0.1)	NA	NA	NA	NA	NA	NA	NA	NA	ND(0.1)
Nickel	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	mg/kg	1 (GSIP,GSIP-SDBL,SDBL)	0.8 (GSIP,GSIP-SDBL,SDBL)	ND(0.5)	NA	NA	NA	NA	NA	NA	NA	NA	0.67 (GSIP,GSIP-SDBL,SDBL)
Zinc	mg/kg	30	39	5.1	NA	NA	NA	NA	NA	NA	NA	NA	66 (SDBL)

Historic Analytical Soil Data
Flint West, Building 9

Location ID: / Date Collected:	Units	SP-1 06/25/98	SP-1 06/25/98	SP-1 06/25/98	SP-1-B9 03/25/97	SP-1-B9 03/25/97	SP-2 06/25/98	SP-2 06/25/98	SP-2 06/25/98	SP-2-B9 03/25/97	SP-2-B9 03/25/97	SP-3 06/25/98	SP-3 06/25/98
Detected VOCs													
Benzene	mg/kg	ND(0.05)	ND(0.05)	ND(0.05)	NA	NA	ND(0.05)	ND(0.05)	NA	NA	NA	ND(0.05)	ND(0.05)
cis-1,2-Dichloroethene	mg/kg	ND(0.05)	ND(0.05)	ND(0.05)	NA	NA	ND(0.05)	ND(0.05)	NA	NA	NA	ND(0.05)	ND(0.05)
Ethylbenzene	mg/kg	ND(0.05)	ND(0.05)	ND(0.05)	NA	NA	ND(0.05)	ND(0.05)	NA	NA	NA	ND(0.05)	ND(0.05)
Toluene	mg/kg	ND(0.05)	ND(0.05)	ND(0.05)	NA	NA	ND(0.05)	ND(0.05)	NA	NA	NA	ND(0.05)	ND(0.05)
trans-1,2-Dichloroethene	mg/kg	ND(0.05)	ND(0.05)	ND(0.05)	NA	NA	ND(0.05)	ND(0.05)	NA	NA	NA	ND(0.05)	ND(0.05)
Trichloroethene	mg/kg	ND(0.05)	ND(0.05)	ND(0.05)	ND	ND	ND(0.05)	ND(0.05)	NA	ND	0.023 J	ND(0.05)	ND(0.05)
Vinyl chloride	mg/kg	ND(0.1)	ND(0.1)	ND(0.1)	NA	NA	ND(0.1)	ND(0.1)	NA	NA	NA	ND(0.1)	ND(0.1)
Xylene (total)	mg/kg	ND	ND	ND	ND	ND	ND	ND	NA	0.054 J	ND	ND	ND
Detected SVOCs													
2-Methylnaphthalene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	ND(0.33)	NA	NA	ND(0.33)	ND(0.33)
Acenaphthene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	ND(0.33)	NA	NA	ND(0.33)	ND(0.33)
Anthracene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	ND(0.66)	NA	NA	ND(0.33)	ND(0.33)
Benzo(a)anthracene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	ND(0.66)	NA	NA	ND(0.33)	ND(0.33)
Benzo(a)pyrene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	ND(0.66)	NA	NA	ND(0.33)	ND(0.33)
Benzo(b)fluoranthene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	ND(0.66)	NA	NA	ND(0.33)	ND(0.33)
Benzo(g,h,i)perylene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	ND(0.66)	NA	NA	ND(0.33)	ND(0.33)
Benzo(k)fluoranthene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	ND(0.66)	NA	NA	ND(0.33)	ND(0.33)
Butyl benzylphthalate	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	ND(0.66)	NA	NA	ND(0.33)	ND(0.33)
Dibenz(a,h)anthracene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	ND(0.66)	NA	NA	ND(0.33)	ND(0.33)
Dibenzofuran	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-butylphthalate	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-octyl phthalate	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	ND(0.66)	NA	NA	ND(0.33)	ND(0.33)
Fluorene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	ND(0.66)	NA	NA	ND(0.33)	ND(0.33)
Indeno(1,2,3-cd)pyrene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	ND(0.66)	NA	NA	ND(0.33)	ND(0.33)
Naphthalene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	ND(0.33)	NA	NA	ND(0.33)	ND(0.33)
Phenanthrene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	ND(0.66)	NA	NA	ND(0.33)	ND(0.33)
Pyrene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	ND(0.66)	NA	NA	ND(0.33)	ND(0.33)
Detected PCBs													
Total PCBs	mg/kg	ND	ND	ND	NA	NA	ND	NA	ND	NA	NA	ND	ND
Detected Inorganics													
Arsenic	mg/kg	13 (RDC,RDC-SDBL,SDBL)	8 (RDC,RDC-SDBL,SDBL)	7.8 (RDC,RDC-SDBL,SDBL)	4.7 J	1.3 J	6.3 (SDBL)	NA	5.6	5.3 J	2.5 J	5.5	6.3 (SDBL)
Barium	mg/kg	100 (SDBL)	39	57	2 J	19 J	15	NA	16	28 J	67 J	16	11
Cadmium	mg/kg	0.35	0.11	0.65	0.11 J	0.053 J	0.091	NA	0.094	0.074 J	0.13 J	0.087	0.12
Chromium Total	mg/kg	23 (GSIP,GSIP-SDBL,SDBL)	8.6 (GSIP)	5.3 (GSIP)	10 J (GSIP)	2.3 J	5.1 (GSIP)	NA	5.7 (GSIP)	12 J (GSIP)	13 J (GSIP)	5.4 (GSIP)	11 (GSIP)
Copper	mg/kg	26	5.9	5.3	8.7 J	1.9 J	6.6	NA	5.2	10 J	6.2 J	4.9	4.7
Lead	mg/kg	180 (SDBL)	11	8.6	13 J	5.2 J	8.2	NA	6.4	14 J	12 J	5.9	12
Mercury	mg/kg	ND(0.1)	ND(0.1)	3.4 (GSIP,GSIP-SDBL,IDWP,IDWP-SDBL,RDWP,RDWP-SDBL,SDBL)	NA	NA	ND(0.1)	NA	ND(0.1)	NA	NA	ND(0.1)	ND(0.1)
Nickel	mg/kg	NA	NA	NA	14 J	3 J	NA	NA	NA	18 J	13 J	NA	NA
Selenium	mg/kg	ND(0.5)	ND(0.5)	ND(0.5)	NA	NA	ND(0.5)	NA	ND(0.5)	NA	NA	ND(0.5)	ND(0.5)
Zinc	mg/kg	220 (SDBL)	27	27	30 J	8.3 J	44	NA	25	31 J	31 J	22	23

Historic Analytical Soil Data
Flint West, Building 9

Location ID: / Date Collected:	Units	SP-3-B9 03/25/97	SP-3-B9 03/25/97	SP-4 06/25/98	SP-4 06/25/98	SP-4-B9 03/25/97	SP-4-B9 03/25/97	SP-5 06/25/98	SP-5-B9 03/25/97	SP-5-B9 03/25/97	SP-6 03/25/97
Detected VOCs											
Benzene	mg/kg	NA	NA	ND(0.05)	ND(0.05)	NA	NA	ND(0.05)	NA	NA	NA
cis-1,2-Dichloroethene	mg/kg	NA	NA	ND(0.05)	ND(0.05)	ND	ND	ND(0.05)	1.8 J (IDWP,IDWP-SDBL,RDWP,RDWP-SDBL)	0.3 J	ND
Ethylbenzene	mg/kg	NA	NA	ND(0.05)	ND(0.05)	NA	NA	ND(0.05)	NA	NA	NA
Toluene	mg/kg	NA	NA	ND(0.05)	ND(0.05)	NA	NA	ND(0.05)	NA	NA	NA
trans-1,2-Dichloroethene	mg/kg	NA	NA	ND(0.05)	ND(0.05)	ND	ND	ND(0.05)	0.021 J	ND	ND
Trichloroethene	mg/kg	ND	0.012 J	ND(0.05)	ND(0.05)	ND	0.25 (IDWP,IDWP-SDBL,RDWP,RDWP-SDBL)	ND(0.05)	2.1 J (IDWP,IDWP-SDBL,RDWP,RDWP-SDBL)	3 J (IDWP,IDWP-SDBL,RDWP,RDWP-SDBL)	0.013 J
Vinyl chloride	mg/kg	NA	NA	ND(0.1)	ND(0.1)	ND	ND	ND(0.1)	0.017 J	ND	ND
Xylene (total)	mg/kg	ND	ND	ND	ND	NA	NA	ND	NA	NA	NA
Detected SVOCs											
2-Methylnaphthalene	mg/kg	NA	NA	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	NA	NA
Acenaphthene	mg/kg	NA	NA	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	NA	NA
Anthracene	mg/kg	NA	NA	ND(0.33)	ND(0.33)	1.7 J	ND(0.33)	ND(0.33)	3.3 J	1.9 J	ND(0.33)
Benzo(a)anthracene	mg/kg	NA	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	0.71 J	0.34 J	ND(0.33)
Benzo(a)pyrene	mg/kg	NA	NA	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	NA	NA
Benzo(b)fluoranthene	mg/kg	NA	NA	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	NA	NA
Benzo(g,h,i)perylene	mg/kg	NA	NA	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	NA	NA
Benzo(k)fluoranthene	mg/kg	NA	NA	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	NA	NA
Butyl benzylphthalate	mg/kg	NA	NA	NA	NA	ND(0.33)	ND(0.33)	NA	0.71 J	0.68 J	ND(0.33)
Chrysene	mg/kg	NA	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	3.1 J	0.95 J	ND(0.33)
Dibenz(a,h)anthracene	mg/kg	NA	NA	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	NA	NA
Dibenzofuran	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-butylphthalate	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-octyl phthalate	mg/kg	NA	NA	NA	NA	0.56 J	ND(0.33)	NA	0.67 J	0.65 J	ND(0.33)
Fluoranthene	mg/kg	NA	NA	ND(0.33)	ND(0.33)	3.1 J	ND(0.33)	ND(0.33)	9.7 J (GSIP,GSIP-SDBL)	4.7 J	ND(0.33)
Fluorene	mg/kg	NA	NA	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	NA	NA
Indeno(1,2,3-cd)pyrene	mg/kg	NA	NA	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	NA	NA
Naphthalene	mg/kg	NA	NA	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	NA	NA	NA
Phenanthrene	mg/kg	NA	NA	ND(0.33)	ND(0.33)	2.1 J	ND(0.33)	ND(0.33)	7.9 J (GSIP,GSIP-SDBL)	2.3 J	ND(0.33)
Pyrene	mg/kg	NA	NA	ND(0.33)	ND(0.33)	0.91 J	ND(0.33)	ND(0.33)	3.6 J	1.1 J	ND(0.33)
Detected PCBs											
Total PCBs	mg/kg	NA	NA	ND	ND	ND	ND	ND	0.66 J	ND	ND
Detected Inorganics											
Arsenic	mg/kg	5.2 J	1.6 J	5.3	4.9	4.9 J	1.6 J	12 (RDC,RDC-SDBL,SDBL)	7.2 J (SDBL)	5.2 J	1.9 J
Barium	mg/kg	46 J	1 J	13	11	33 J	21 J	38	130 J (SDBL)	36 J	79 J (SDBL)
Cadmium	mg/kg	0.15 J	ND(0.05)	0.13	0.073	0.16 J	ND(0.05)	0.057	0.41 J	0.12 J	0.16 J
Chromium Total	mg/kg	16 J (GSIP)	2.7 J	6.9 (GSIP)	4.4 (GSIP)	15 J (GSIP)	3.1 J	7.8 (GSIP)	11 J (GSIP)	12 J (GSIP)	8.5 J (GSIP)
Copper	mg/kg	1 J	4 J	5.2	4.6	23 J	2.2 J	12	27 J	8.9 J	6.3 J
Lead	mg/kg	68 J (SDBL)	3.2 J	9.5	7.9	16 J	4.9 J	12	280 J (SDBL)	19 J	37 J (SDBL)
Mercury	mg/kg	NA	NA	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	0.29 J (GSIP,GSIP-SDBL,SDBL)	ND(0.1)	ND(0.1)
Nickel	mg/kg	13 J	5 J	NA	NA	21 J (SDBL)	3.1 J	NA	14 J	17 J	12 J
Selenium	mg/kg	NA	NA	ND(0.5)	ND(0.5)	NA	NA	ND(0.5)	NA	NA	NA
Zinc	mg/kg	42 J	9 J	24	19	45 J	8.3 J	20	200 J (SDBL)	37 J	45 J

Historic Analytical Soil Data
Flint West, Building 9

Location ID: / Date Collected:	Units	SP-6 03/25/97	SP-6 03/25/97	SP-7/SB1 03/25/97	SP-7/SB1 03/25/97	SP-8 03/25/97	SP-8 03/25/97	SP-9 03/25/97	SP-9 03/25/97	SP-9 03/25/97	SP-10/SB3 03/25/97	SP-10/SB3 03/25/97	SP-11 03/25/97	SP-12 03/25/97
Detected VOCs														
Benzene	mg/kg	NA	NA	NA	NA	ND(0.01)	ND(0.01)	NA	NA	NA	ND	ND	ND	ND
cis-1,2-Dichloroethene	mg/kg	ND	ND	0.34 J	0.028 J	ND(0.01)	ND(0.01)	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	mg/kg	NA	NA	NA	NA	ND(0.01)	ND(0.01)	NA	NA	NA	ND	ND	ND	ND
Toluene	mg/kg	NA	NA	NA	NA	ND(0.01)	ND(0.01)	NA	NA	NA	ND	ND	ND	ND
trans-1,2-Dichloroethene	mg/kg	ND	ND	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	NA
Trichloroethene	mg/kg	ND	ND	0.66 J (IDWP,IDWP-SDBL,RDWP,RDWP-SDBL)	0.072 J	ND(0.01)	ND(0.01)	0.034 J	0.015 J	0.01 J	ND	ND	ND	ND
Vinyl chloride	mg/kg	ND	ND	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	NA
Xylene (total)	mg/kg	NA	NA	NA	NA	ND(0.01)	ND(0.01)	NA	NA	NA	ND	ND	ND	ND
Detected SVOCs														
2-Methylnaphthalene	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	mg/kg	ND(0.33)	3.1 J	ND(0.33)	ND(0.33)	0.39 J	ND(0.33)	ND(0.33)	0.56 J	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	0.71 J
Benzo(a)anthracene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	0.36 J	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	NA	NA
Benzo(a)pyrene	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butyl benzylphthalate	mg/kg	ND(0.33)	0.37 J	ND(0.33)	ND(0.33)	NA	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	1.1 J
Chrysene	mg/kg	ND(0.33)	0.56 J	ND(0.33)	ND(0.33)	0.34 J	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	NA	NA
Dibenz(a,h)anthracene	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzofuran	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-butylphthalate	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(0.33)	ND(0.33)	ND(0.33)	0.65 J
Di-n-octyl phthalate	mg/kg	ND(0.33)	1 J	ND(0.33)	ND(0.33)	0.35 J	ND(0.33)	ND(0.33)	0.56 J	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	0.96 J
Fluoranthene	mg/kg	ND(0.33)	4.3 J	ND(0.33)	ND(0.33)	0.86 J	ND(0.33)	ND(0.33)	1.1 J	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	1.1 J
Fluorene	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	mg/kg	ND(0.33)	1.1 J	ND(0.33)	ND(0.33)	0.69 J	ND(0.33)	0.37 J	0.5 J	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	0.98 J
Pyrene	mg/kg	ND(0.33)	0.79 J	ND(0.33)	ND(0.33)	0.76 J	ND(0.33)	ND(0.33)	0.79 J	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	1.2 J
Detected PCBs														
Total PCBs	mg/kg	ND	ND	ND	ND	NA	NA	ND	ND	0.71 J	NA	NA	NA	NA
Detected Inorganics														
Arsenic	mg/kg	6.3 J (SDBL)	2.5 J	3.9 J	3.4 J	4.1 J	3.8 J	3.9 J	1.6 J	3.7 J	5.6 J	2.4 J	5.1 J	6.7 J (SDBL)
Barium	mg/kg	52 J	16 J	72 J	85 J (SDBL)	29 J	45 J	58 J	22 J	52 J	86 J (SDBL)	49 J	30 J	26 J
Cadmium	mg/kg	0.14 J	0.061 J	0.08 J	0.11 J	0.084 J	0.076 J	0.23 J	0.062 J	0.076 J	0.12 J	0.12 J	ND(0.05)	0.066 J
Chromium Total	mg/kg	13 J (GSIP)	0.061 J	10 J (GSIP)	20 J (GSIP,GSIP-SDBL,SDBL)	11 J (GSIP)	8.3 J (GSIP)	6.9 J (GSIP)	3.6 J (GSIP)	6.9 J (GSIP)	14 J (GSIP)	13 J (GSIP)	8.6 J (GSIP)	23 J (GSIP,GSIP-SDBL,SDBL)
Copper	mg/kg	11 J	7.1 J	8.6 J	11 J	6.9 J	5.2 J	8.3 J	4.1 J	6.2 J	9.8 J	7.6 J	13 J	19 J
Lead	mg/kg	12 J	4.3 J	11 J	13 J	11 J	6.1 J	8.9 J	3.8 J	6.2 J	14 J	11 J	68 J (SDBL)	17 J
Mercury	mg/kg	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	NA	NA	NA	NA
Nickel	mg/kg	27 J (SDBL)	8.5 J	17 J	24 J (SDBL)	15 J	12 J	16 J	6.3 J	30 J (SDBL)	16 J	16 J	18 J	26 J (SDBL)
Selenium	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	mg/kg	18 J	18 J	33 J	44 J	23 J	23 J	59 J (SDBL)	23 J	23 J	39 J	30 J	29 J	26 J

Historic Analytical Soil Data
Flint West, Building 9

Location ID: / Date Collected:	Units	SP-12 03/25/97	SP-13 03/25/97	SP-13 03/25/97	SP-15 03/25/97	SP-16 03/25/97	SP-16 03/25/97	SP-17 03/25/97	SP-17 03/25/97	SP-18 03/25/97
Detected VOCs										
Benzene	mg/kg	0.054 J	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)	0.019 J	0.049 J	ND(0.01)	ND(0.01)
cis-1,2-Dichloroethene	mg/kg	0.013 J	ND(0.01)	ND(0.01)	0.019 J	0.19 J	0.011 J	0.01 J	ND(0.01)	ND(0.01)
Ethylbenzene	mg/kg	0.018 J	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)	0.02 J	0.034 J	ND(0.01)	ND(0.01)
Toluene	mg/kg	0.024 J	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)	0.041 J	0.05 J	ND(0.01)	ND(0.01)
trans-1,2-Dichloroethene	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	mg/kg	0.021 J	0.01 J	ND(0.01)	0.013 J	0.03 J	0.031 J	0.022 J	ND(0.01)	ND(0.01)
Vinyl chloride	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA
Xylene (total)	mg/kg	0.077 J	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)	0.063 J	0.108 J	ND(0.01)	ND(0.01)
Detected SVOCs										
2-Methylnaphthalene	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	NA
Acenaphthene	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	NA
Anthracene	mg/kg	ND(0.33)	ND(0.33)	0.6 J	ND(0.33)	0.41 J	0.33 J	0.56 J	1.1 J	ND(0.33)
Benzo(a)anthracene	mg/kg	NA	0.36 J	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Benzo(a)pyrene	mg/kg	NA	ND(0.33)	0.35 J	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	NA
Benzo(b)fluoranthene	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	NA
Benzo(g,h,i)perylene	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	NA
Benzo(k)fluoranthene	mg/kg	NA	0.34 J	0.34 J	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	NA
Butyl benzylphthalate	mg/kg	0.55 J	ND(0.33)	ND(0.33)	ND(0.33)	0.34 J	ND(0.33)	NA	NA	NA
Chrysene	mg/kg	NA	0.34 J	0.35 J	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Dibenz(a,h)anthracene	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	NA
Dibenzofuran	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	NA
Di-n-butylphthalate	mg/kg	ND(0.33)	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-octyl phthalate	mg/kg	ND(0.33)	0.49 J	0.71 J	ND(0.33)	0.72 J	ND(0.33)	ND(0.33)	0.61 J	ND(0.33)
Fluoranthene	mg/kg	0.47 J	0.67 J	ND(0.33)	ND(0.33)	0.61 J	0.63 J	0.34 J	0.62 J	ND(0.33)
Fluorene	mg/kg	NA	ND(0.33)	1.2 J	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	NA
Indeno(1,2,3-cd)pyrene	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	NA
Naphthalene	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	NA	NA	NA
Phenanthrene	mg/kg	0.86 J	0.36 J	0.69 J	ND(0.33)	0.79 J	0.94 J	0.89 J	0.93 J	ND(0.33)
Pyrene	mg/kg	0.79 J	0.69 J	1.4 J	ND(0.33)	0.81 J	0.73 J	0.59 J	0.73 J	ND(0.33)
Detected PCBs										
Total PCBs	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA
Detected Inorganics										
Arsenic	mg/kg	3.9 J	3.7 J	3.1 J	42 J (C4DC,C4DC-SDBL,IDC,IDC-SDBL,IDWP,IDWP-SDBL,RDC,RDC-SDBL,RDWP,RDWP-SDBL,SDBL)	6.1 J (SDBL)	2.7 J	5.7 J	3.4 J	3.9 J
Barium	mg/kg	34 J	54 J	46 J	450 J (SDBL)	62 J	37 J	62 J	25 J	24 J
Cadmium	mg/kg	0.071 J	0.093 J	0.11 J	0.38 J	0.088 J	0.075 J	0.24 J	0.065 J	0.14 J
Chromium Total	mg/kg	13 J (GSIP)	10 J (GSIP)	9.5 J (GSIP)	55 J (GSIP,GSIP-SDBL,IDWP,IDWP-SDBL,RDWP,RDWP-SDBL,SDBL)	16 J (GSIP)	10 J (GSIP)	16 J (GSIP)	11 J (GSIP)	19 J (GSIP,GSIP-SDBL,SDBL)
Copper	mg/kg	8 J	7.2 J	6.4 J	65 J (SDBL)	16 J	7.2 J	21 J	17 J	11 J
Lead	mg/kg	9.2 J	13 J	13 J	55 J (SDBL)	14 J	7.7 J	41 J (SDBL)	3.3 J	13 J
Mercury	mg/kg	NA	NA	NA	NA	NA	NA	ND(0.1)	ND(0.1)	ND(0.1)
Nickel	mg/kg	14 J	13 J	13 J	43 J (SDBL)	21 J (SDBL)	11 J	26 J (SDBL)	16 J	24 J (SDBL)
Selenium	mg/kg	NA	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	NA	NA	NA
Zinc	mg/kg	22 J	35 J	44 J	43 J	39 J	23 J	120 J (SDBL)	25 J	49 J (SDBL)

Historic Analytical Soil Data
Flint West, Building 9

Location ID: Date Collected:	Units	SP-18 03/25/97	SP-19 03/25/97	SP-19 03/25/97	SP-20 03/25/97	SP-20 03/25/97	SP-21 03/25/97
Detected VOCs							
Benzene	mg/kg	ND(0.01)	ND(0.01)	0.01 J	ND(0.01)	ND(0.01)	ND(0.01)
cis-1,2-Dichloroethene	mg/kg	0.052 J	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)	0.024 J
Ethylbenzene	mg/kg	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)
Toluene	mg/kg	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)
trans-1,2-Dichloroethene	mg/kg	NA	NA	NA	NA	NA	NA
Trichloroethene	mg/kg	0.82 J (IDWP,IDWP-SDBL,RDWP,RDWP-SDBL)	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)	0.024 J
Vinyl chloride	mg/kg	NA	NA	NA	NA	NA	NA
Xylene (total)	mg/kg	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)	ND(0.01)
Detected SVOCs							
2-Methylnaphthalene	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Acenaphthene	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Anthracene	mg/kg	ND(0.33)	0.65 J	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Benzo(a)anthracene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Benzo(a)pyrene	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Benzo(b)fluoranthene	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Benzo(g,h,i)perylene	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Benzo(k)fluoranthene	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Butyl benzylphthalate	mg/kg	NA	0.34 J	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Chrysene	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Dibenz(a,h)anthracene	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Dibenzofuran	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Di-n-butylphthalate	mg/kg	NA	NA	NA	NA	NA	NA
Di-n-octyl phthalate	mg/kg	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Fluoranthene	mg/kg	ND(0.33)	0.85 J	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Fluorene	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Indeno(1,2,3-cd)pyrene	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Naphthalene	mg/kg	NA	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Phenanthrene	mg/kg	ND(0.33)	0.67 J	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Pyrene	mg/kg	ND(0.33)	0.48 J	ND(0.33)	ND(0.33)	ND(0.33)	ND(0.33)
Detected PCBs							
Total PCBs	mg/kg	NA	NA	NA	NA	NA	NA
Detected Inorganics							
Arsenic	mg/kg	3 J	3.7 J	4.7 J	4.9 J	2.4 J	5.1 J
Barium	mg/kg	23 J	34 J	39 J	35 J	38 J	20 J
Cadmium	mg/kg	0.06 J	0.15 J	0.12 J	0.13 J	0.054 J	0.1 J
Chromium Total	mg/kg	6 J (GSIP)	22 J (GSIP,GSIP-SDBL,SDBL)	12 J (GSIP)	11 J (GSIP)	4.3 J (GSIP)	12 J (GSIP)
Copper	mg/kg	3.7 J	7.7 J	12 J	11 J	3.6 J	12 J
Lead	mg/kg	3.5 J	14 J	11 J	13 J	4.4 J	25 J (SDBL)
Mercury	mg/kg	ND(0.1)	NA	NA	NA	NA	NA
Nickel	mg/kg	6.3 J	17 J	17 J	17 J	5.1 J	19 J
Selenium	mg/kg	NA	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
Zinc	mg/kg	14 J	30 J	34 J	32 J	13 J	42 J

Notes

	Exceeds Criteria
ft bgs	feet below ground surface
mg/kg	milligrams per kilogram
PCBs	Polychlorinated biphenols
SVOCs	Semi volatile organic compounds
VOCs	Volatile organic compounds
C3DC	Commercial III Direct Contact Criteria
C3DC-SDBL	Commercial III Direct Contact Criteria - Statewide Default Background Levels
C4DC	Commercial IV Direct Contact Criteria
C4DC-SDBL	Commercial IV Direct Contact Criteria - Statewide Default Background Levels
CSAT	Michigan Soil Saturation Screening Limit
CSAT-SDBL	Michigan Soil Saturation Screening Limit - Statewide Default Background Levels
GCCP	Groundwater Contact Protection Criteria
GCCP-SDBL	Groundwater Contact Protection Criteria - Statewide Default Background Levels
GSIP	Groundwater Surface Water Interface Protection Criteria
GSIP-SDBL	Groundwater Surface Water Interface Protection Criteria - Statewide Default Background Levels
IDC	Generic Industrial Direct Contact Values
IDC-SDBL	Generic Industrial Direct Contact Values - Statewide Default Background Levels
IDWP	Industrial & Commercial Drinking Water Protection Criteria
IDWP-SDBL	Industrial & Commercial Drinking Water Protection Criteria - Statewide Default Background Levels
IPSIC	Industrial & Commercial II, III, & IV Particulate Soil Inhalation Criteria
IPSIC-SDBL	Industrial & Commercial II, III, & IV Particulate Soil Inhalation Criteria - Statewide Default Background Levels
ISVIA	Industrial & Commercial II, III, & IV Soil Volatilization to Indoor Air Inhalation Criteria
ISVIA-SDBL	Industrial & Commercial II, III, & IV Soil Volatilization to Indoor Air Inhalation Criteria - Statewide Default Background Levels
IVSIC2	Industrial & Commercial II, III, & IV Finite VSIC for 2 Meter Source Thickness
IVSIC2-SDBL	Industrial & Commercial II, III, & IV Finite VSIC for 2 Meter Source Thickness - Statewide Default Background Levels
IVSIC5	Industrial & Commercial II, III, & IV Finite VSIC for 5 Meter Source Thickness
IVSIC5-SDBL	Industrial & Commercial II, III, & IV Finite VSIC for 5 Meter Source Thickness - Statewide Default Background Levels
IVSICI	Industrial & Commercial II, III, & IV Infinite Source Volatile Soil Inhalation Criteria (VSIC)
IVSICI-SDBL	Industrial & Commercial II, III, & IV Infinite Source Volatile Soil Inhalation Criteria (VSIC) - Statewide Default Background Levels
RDC	Residential & Commercial I Direct Contact Values
RDC-SDBL	Residential & Commercial I Direct Contact Values - Statewide Default Background Levels
RDWP	Residential Drinking Water Protection Criteria
RDWP-SDBL	Residential Drinking Water Protection Criteria - Statewide Default Background Levels
RPSIC	Residential & Commercial I Particulate Soil Inhalation Criteria
RPSIC-SDBL	Residential & Commercial I Particulate Soil Inhalation Criteria - Statewide Default Background Levels
RSVIA	Residential & Commercial I Soil Volatilization to Indoor Air Inhalation Criteria
RSVIA-SDBL	Residential & Commercial I Soil Volatilization to Indoor Air Inhalation Criteria - Statewide Default Background Levels
RVSIC2	Residential & Commercial I Finite VSIC for 2 Meter Source Thickness
RVSIC2-SDBL	Residential & Commercial I Finite VSIC for 2 Meter Source Thickness - Statewide Default Background Levels
RVSIC5	Residential & Commercial I Finite VSIC for 5 Meter Source Thickness
RVSIC5-SDBL	Residential & Commercial I Finite VSIC for 5 Meter Source Thickness - Statewide Default Background Levels
RVSICI	Residential & Commercial I Infinite Source Volatile Soil Inhalation Criteria (VSIC)
RVSICI-SDBL	Residential & Commercial I Infinite Source Volatile Soil Inhalation Criteria (VSIC) - Statewide Default Background Levels
SDBL	Statewide Default Background Levels

APPENDIX C

ARCADIS

Appendix C

MDEQ Operational Memorandum No. 2 and Attachments

Remediation and
Redevelopment Division

Michigan Department of Environmental Quality

October 22, 2004

RRD OPERATIONAL MEMORANDUM NO. 2

SUBJECT: SAMPLING AND ANALYSIS

Key definitions for terms used in this document:

NREPA:	The Natural Resources and Environmental Protection Act, 1994 PA 451, as amended
Part 201:	Part 201, Environmental Remediation, of NREPA
Part 211:	Part 211, Underground Storage Tank Regulations, of NREPA
Part 213:	Part 213, Leaking Underground Storage Tanks, of NREPA
MDEQ:	Michigan Department of Environmental Quality
RRD:	Remediation and Redevelopment Division
Criteria or criterion:	Includes the cleanup criteria for Part 201 and the Risk-based Screening Levels as defined in Part 213 and R 299.5706a(4)
Facility:	Includes "facility" as defined by Part 201 and "site" as defined by Part 213
Response Action:	Includes "response activities" as defined by Part 201 and "corrective action" as defined by Part 213

PURPOSE

This operational memorandum has been prepared to facilitate implementation of Part 201, Part 211, and Part 213. This operational memorandum supercedes all previous MDEQ Part 201, Part 211, and Part 213 sampling and analysis guidance.

Generic cleanup criteria for groundwater and soil have been developed pursuant to Sections 20120a(1) and 21304a of NREPA (see RRD Operational Memorandum No. 1). These criteria are the risk-based values the department has determined to be protective of the public health, safety, or welfare and the environment. The evaluation of sampling data to establish compliance with cleanup criteria under the provisions of Part 201, Part 211, and Part 213 requires data that reliably establish representative concentrations of the hazardous substances in a given environmental medium. To facilitate gathering the information necessary for the department to determine compliance with the applicable provisions of Part 201, Part 211, or Part 213, this operational memorandum designates consistent sampling and analysis protocols and consolidates, as attachments, specific sampling and analysis related specifications for the following:

Attachment 1. Target Detection Limits and Designated Analytical Methods

This attachment provides direction for analytical target detection limits for site assessment, site investigation, and response activities under Part 201, Part 211, and Part 213. This attachment constitutes the department's published list of target detection limits and available analytical methods pursuant to R 299.5103(l).

Attachment 2. Soil Leaching Methods

This attachment provides specifications for soil leaching methods acceptable to the department to establish the concentration of a hazardous substance leaching from soil. Alternate methods are provided pursuant to R299.5722(3)(b).

Attachment 3. Indoor Air Designated Methods and Target Detection Limits

This attachment provides direction for acceptable methods and analytical target detection limits for acceptable indoor air concentrations for response activities under Part 201, and Part 213.

Attachment 4. Sample Preservation, Sample Handling, and Holding Time Specifications

This attachment provides specifications applicable for the collection, preservation, holding times, and handling of groundwater and soil samples applicable to site assessment, site investigation, and response activities under Part 201, Part 211, and Part 213.

Attachment 5. Collection of Samples for Comparison to Generic Criteria

This attachment provides direction for collection of groundwater and soils samples. Additional guidance regarding sampling strategies is available in RRD Operational Memorandum No. 4.

Attachment 6. Sampling Methods for Volatile Organic Compounds

This attachment provides specifications for the collection and preservation of samples collected to determine concentrations of volatile organic compounds, and is applicable for site assessments, site investigations, and response activities under Part 201, Part 211, and Part 213.

Attachment 7. Low Level Mercury Sampling Specifications

This attachment provides specifications for the collection of groundwater samples from monitoring wells to determine mercury concentrations for the evaluation of groundwater that vents to surface water, and is applicable to site assessments, site investigation, and response activities under Part 201, Part 211, and Part 213.

Attachment 8. Assessments for Sites Contaminated with Petroleum Products

This attachment provides direction for the assessment of sites contaminated with petroleum products released from leaking underground storage tanks, and is applicable to site assessment, site investigation, and response activities under Part 211, and Part 213.

This document is intended to provide direction and guidance for sampling and analysis conducted for facilities regulated under Part 201, Part 211, and Part 213. State programs administered under other parts of NREPA or Federal programs may have requirements in addition to this guidance. Questions about sampling and analysis requirements should be directed to appropriate program staff.

original signed by Andrew W. Hogarth on October 22, 2004 Dated:__________________

Andrew W. Hogarth, Chief

Remediation and Redevelopment Division

ATTACHMENTS

This memorandum and its attachments are intended to provide direction and guidance to foster consistent application of Part 201, Part 211, and Part 213 and the associated administrative rules. This document is not intended to convey any rights to any parties or create any duties or responsibilities under the law. This document and matters addressed herein are subject to revision.

Remediation and Redevelopment Division

Michigan Department of Environmental Quality

October 22, 2004

RRD OPERATIONAL MEMORANDUM NO. 2

SUBJECT: **SAMPLING AND ANALYSIS - ATTACHMENT 1**
TARGET DETECTION LIMITS AND DESIGNATED ANALYTICAL METHODS

Key definitions for terms used in this document:

NREPA:	The Natural Resources and Environmental Protection Act, 1994 PA 451, as amended
Part 201:	Part 201, Environmental Remediation, of NREPA
Part 211:	Part 211, Underground Storage Tank Regulations, of NREPA
Part 213:	Part 213, Leaking Underground Storage Tanks, of NREPA
MDEQ:	Michigan Department of Environmental Quality
RRD:	Remediation and Redevelopment Division
U.S. EPA:	United States Environmental Protection Agency
Criteria or criterion:	Includes the cleanup criteria for Part 201 and the Risk-based Screening Levels as defined in Part 213 and R299.5706a(4).
Facility:	Includes "facility" as defined by Part 201 and "site" as defined by Part 213
Response Actions:	Includes "response activities" as defined in Part 201 and "corrective action" as defined in Part 213

PURPOSE

This attachment to RRD Operational Memorandum No. 2 provides direction for analytical target detection limits (TDLs) for response actions under Part 201 and Part 213 and site assessments under Part 211. This attachment constitutes the department's published list of analytical target detection limits for hazardous substances and available analytical methods that are capable of achieving the target detection limits pursuant to R 299.5103(l).

The TDLs and designated analytical methods identified in this attachment shall apply to all sampling and analysis conducted more than 30 days after the date of issuance of Operational Memorandum No. 2.

Generic cleanup criteria for groundwater and soil have been developed pursuant to Sections 20120a(1) and 21304a of NREPA (see RRD Operational Memorandum No. 1). These criteria are the risk-based values the department has determined to be protective of the public health, safety, or welfare and the environment. The evaluation of sampling data to establish compliance with cleanup criteria under the provisions of Part 201, Part 211, and Part 213 requires the data reliably establish a representative concentration of the hazardous substance in a given environmental medium. This attachment establishes analytical target detection limits for hazardous substances and designates available analytical methods that are capable of achieving the target detection limits to facilitate gathering the information necessary for the department to determine compliance with the applicable provisions of Part 201, Part 211, or Part 213.

TARGET DETECTION LIMITS

Analytical TDLs have been established by the MDEQ for hazardous substances with generic cleanup criteria. In establishing TDLs the MDEQ considered the need to be able to measure the hazardous substances at concentrations at or below cleanup criteria. The TDLs were derived by reviewing the low-level capabilities of state laboratories and methods published by government agencies and referenced in this document.

If the established TDL is greater than the risk-based cleanup criteria for a hazardous substance in a given environmental medium, the TDL shall be used in place of the risk-based value as the cleanup criterion.

For soil matrices, laboratory reporting limits should be equal to, or less than, the listed TDLs on a dry weight basis. For groundwater matrices, laboratory reporting limits should be equal to, or less than, the listed TDLs. Achieving the TDL is critical for site assessment and site investigation activities where the objective is the characterization of the nature and extent of contamination. For response activities under Part 201 or Part 213, where the goal is to determine compliance with applicable cleanup criteria alternate TDLs may be used if the pathways with the most restrictive cleanup criteria are appropriately determined to be "not relevant" and are therefore not applicable. Alternate TDLs are footnoted with the relevant pathway's applicable criteria.

DESIGNATED METHODS

Table 1 identifies the TDLs and the analytical methods judged capable of achieving the TDLs. The source documents for the analytical methods are listed in Table 2. The designated analytical methods include multiple methods in those cases where more than one method has been judged capable of achieving the TDL.

Alternate Acceptable Analytical Methods: The methods listed in Table 1 are primarily from Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Edition 3, (SW-846) Office of Solid Waste & Emergency Response, U.S. EPA. Alternate methods, and revisions of the listed methods, may be used with prior written approval of the RRD. Except when specifically indicated in this document, prior written approval is not needed for the following specific cases:

- Revisions of methods in Table 1 from subsequent revisions published in SW-846.
- Methods approved by the U.S. EPA for use in the Contract Laboratory Program (CLP).
- Methods promulgated for use under the Federal Safe Drinking Water Act that are acceptable for raw source and finished drinking waters.
- Methods promulgated for use under the Federal Clean Water Act that are acceptable for wastewater, groundwater and surface water analysis.

Confirmations: Gas chromatography methods with mass spectrometry (GC/MS) confirmations of the contaminants' identity are preferred when the TDL can be met. When other GC methods are used, confirmation techniques should be used whenever possible such as measurements on dual columns and confirmation of a select number of samples with high levels of the contaminants that can be detected and confirmed by GC/MS.

CONTAMINANTS WITH TDLS HIGHER THAN THE MOST RESTRICTIVE CRITERIA

Table 6 lists contaminants that have TDLs greater than the most restrictive risk-based criteria. These TDLs are also identified in Table 1 through the use of bold font and by enclosing the TDLs with brackets. For these contaminants, laboratories should always report results below the TDL down to the laboratory's limits of detection. Appropriate codes must be used to indicate that the results are below the laboratory's reporting limits and are estimated. The results will be interpreted as provided in R299.5742.

CONTAMINANTS WITHOUT TDLS OR DESIGNATED ANALYTICAL METHODS

Table 7 lists contaminants with established risk-based criteria that do not have TDLs or designated analytical methods. For these contaminants, or for contaminants with no established criteria, proposed appropriate TDLs and analytical methods should be submitted to the MDEQ for review and approval. Analytical methods proposed must be supported by submission of detailed descriptions of the methods and method performance validations. When methods used are listed in Table 1 and applied to contaminants not listed in the published method, method performance validations for those contaminants must be provided to the MDEQ.

ELEVATION OF REPORTING LIMITS

Reporting limits may be elevated above the TDLs because of matrix effects, including interferences resulting from non-target or high levels of target compounds, interferences from species native to the sample matrices under investigation, and when results from the analysis of soils are adjusted for the moisture content. The use of elevated reporting limits must be approved by the MDEQ. For response actions under Part 201 or Part 213, elevated reporting limits may be acceptable if the most restrictive cleanup criterion is not exceeded. For contaminants where the TDLs are greater than the most restrictive risk-based criteria (Table 7) elevated reporting limits may be unacceptable. When reporting limits are increased for these contaminants, or when increased beyond the cleanup criteria, it is necessary to further evaluate the elevated reporting limits. This may include reviews of laboratory procedures to determine their appropriateness, re-analysis at other laboratories, further sample cleanups, modifications to methods, or other actions.

USE OF ALTERNATE REPORTING LIMITS

Alternate reporting limits may be acceptable:

- When site-specific background levels or statewide default background levels for certain metals are substituted as the cleanup criteria, it may not be necessary to report data below the background levels.
- For response actions under Part 201 or Part 213, when the most restrictive criteria has been appropriately documented to not be applicable, reporting limits may be specified, based on the most restrictive applicable criteria.
- When concentrations are determined for off-site waste disposal requirements.
- When sample concentrations lower than the TDL can be quantified; i.e., the lower sample concentrations are within the analytical range of the method.
- When monitoring levels of contaminants lower than the TDLs is necessary, particularly when risk-based criteria are lower than the TDL.

APPLICATION OF REPORTING LIMITS

The TDLs are applicable to site assessments, environmental investigations, and response activities performed pursuant to Part 201, Part 211, and Part 213. They may not be applicable to other environmental statutes. Facilities subject to regulation under other environmental statutes should consult the appropriate MDEQ division.

Questions about this memorandum attachment should be directed as follows:

- Site investigation and response activities under Part 201 and Part 213:
  A. Ralph Curtis, Laboratory Specialist
  Remediation and Redevelopment Division; Toxicology Unit
  Phone: 517-373-8389, FAX: 517-241-9581, Email: curtisar@michigan.gov
- Site assessments under Part 211:
  Marcia Jo Poxson
  Waste and Hazardous Materials Division; Storage Tank Unit
  Phone: 517-373-3290, FAX: 517-335-2245; Email: poxsonm@michigan.gov

The following documents are rescinded with the issuance of this attachment:

- Environmental Response Division Operational Memorandum 6 , Revision 6, Analytical Method Detection Level Guidance for Environmental Contamination Response Activities under Part 201 of NREPA dated January 12, 2001, and addendum dated May 5, 2003.
- Storage Tank Division Operational Memorandum 4, Attachment 13, Analytical Detection Level Guidance under Part 211, and Part 213, of NREPA dated February 15, 2001, and addendum dated May 5, 2003.

Major changes from the direction in the rescinded documents are summarized as follows:

GENERAL CHANGES FROM PREVIOUS GUIDANCE

- The use of CFR 40 Part 136, Appendix B, to confirm TDLs was removed.
- Emphasis was placed on preferring GC/MS methods.
- Table 6 was added that listed contaminants with TDLs higher than the most restrictive criteria.
- Notations were added to contaminants in Table 1 to indicate: pathways that are relevant for the associated TDL; contaminants present in light petroleum products and oxygenates; and contaminants which are solvents commonly used in laboratories.
- Contaminant groupings in Table 1 were altered to increase compatibility with RRD Operational Memorandum No. 2, Attachment 4, Sample Preservation, Sample Handling, and Holding Time Specifications.

CHANGES IN METHODS

- Methods were removed from Table 1 that were never used. Language was added to allow methods from other programs.
- Additional methods approved in SW-846 were added to improve flexibility in choices.
- The notation SIM was added to specific methods, where appropriate, to indicate the use of the selected ion monitoring (SIM) technique for GC/MS methods.
- Methods for the analysis for 1,4-Dioxane that were laboratory specific were replaced with the source methods used.
- The method to determine the fraction of organic matter changed due to method revision.
- The method to determine Dacthal was changed to 8081B.
- Specific extraction methods for soil nitrate, nitrite, fluoride, and chloride were added.

- Language was added to specify distillation of ammonia from soils as the recommended method.
- The extraction method for chlorides was specified as "water extracts," as each laboratory had their own extraction procedure.
- Methods for the analysis for explosives were added.

TDL REVISIONS MADE WITH THIS DOCUMENT

- Table 3 "Contaminants Added to TDL and Designated Analytical Methods Lists" lists contaminants added to the MDEQ TDL and Designated Analytical Methods List .
- Table 4 "Contaminants Removed from TDL and Designated Analytical Methods Lists", lists contaminants removed from the MDEQ TDL and Designated Analytical Methods List .
- Table 5 "Rationale for Reducing TDLs from the Previous Operational Memoranda", lists those TDLs which have been reduced to allow measurement at or nearer to the most restrictive criteria, and rationale for the reduction.

APPENDAGES TO THIS ATTACHMENT:

TABLE 1. Target Detection Limits And Designated Analytical Methods
TABLE 2. Source Documents For Designated Analytical Methods
TABLE 3. New Contaminants Added to TDLs and Designated Analytical Methods List
TABLE 4. Contaminants Removed From TDLs and Designated Analytical Methods List
TABLE 5. Rationale For Reducing TDLs From Previous Operational Memoranda
TABLE 6. TDLS Greater Than The Most Restrictive Risk-based Criteria
TABLE 7. Contaminants With Established Risk-based Criteria And Without TDLs And Designated Analytical Methods

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This memorandum and its attachments are intended to provide direction and guidance to foster consistent application of Part 201, Part 211, and Part 213 and the associated administrative rules. This document is not intended to convey any rights to any parties or create any duties or responsibilities under the law. This document and matters addressed herein are subject to revision.

TABLE 1. TARGET DETECTION LIMITS AND DESIGNATED ANALYTICAL METHODS

Contaminants	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods
Specific Contaminants				
Acetic Acid	64197	[1,000]	20,000	Analysis for acetate is used
Acetate	ACETATE	1,000	20,000	Ion Chromatography [1]
Chloride	16887006	10,000	200,000	300.1 9056 9212 9250 9251 9253 [325 methods] Use water extracts for soils
Dissolved Oxygen	DO	80	-----	360.1 360.2
Fluoride	7782414	1000	5000	9214 300.1 9056 340.1 Soils [2]
Formic Acid	64186	1,000	20,000	Analysis for formate is used
Formate [3]	FORMATE	1,000	20,000	Ion Chromatography [1]
Hardness[4]	HARDCALC	-----	NA	Calculate from separate Ca and Mg results using SM 2340B
Perchlorate	14797730	3	-----	314.0 9058
pH	PH	-----	-----	9040C (waters) 9045D (soils)
Phosphorus (White)	12185103	0.005	1	7580
Phosphorus (total)	7723140	10	200	365.4 (waters) 6010 6020 200.7 200.8 Soils [5]
Petroleum Hydrocarbon Material	PET_HYD	See Method	See Method	1664 9071B 8440
Sulfate	14808798	1000	50,000	300.1 9056 9035 9036 375.1 375.2 Soils [6]
Sulfide, Dissolved .and Acid Solution.	18496258	200	1000	[9030 with 9034 or 9215] 376.1 376.2
Total Dissolved Solids	TDS	10,000	----	160.1
Cyanide [7]	57125			
Cyanide, Available	CN_AVAIL	5	100	OIA 1677 Soils: Extract with 9013. 335.1 Modified for soils.
Cyanide, Amenable	CN_AMEN	5	----	9019B 9012A
Cyanide, Total	CN_TOTAL	----	100	9010B 9012A Kelada-01 335.2
Nitrogen Forms [8]				
Ammonia-N	7664417	25	1000	350.1/2/3 (Waters) For soils see [9]
Nitrate-N	14797558	100	1000	300.1 9056 353.2 For soils see [10]
Nitrite-N	14797650	100	1000	300.1 9056 353.2 For soils see [10]
Kjeldahl-N	TKN	100	1000	351.1 351.2 351.3 351.4
Urea	57136	400	20,000	983.01
Nitrogen, Total (elemental)	7727379	100	1000	See footnote 8

TABLE 1. TARGET DETECTION LIMITS AND DESIGNATED ANALYTICAL METHODS

Metals [11]	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg
Aluminum	7429905	50	1000
Antimony	7440360	2	[300]
Arsenic	7440382	5	100
Barium [12]	7440393	100	1000
Beryllium [12]	7440417	[1]	500
Boron	7440428	300	8000
Cadmium [12]	7440439	1	200
Chromium III	16065831	10	2000
Chromium (total)	7440473	10	2000
Cobalt	7440484	20	500
Copper [12]	7440508	4	1000
Iron	7439896	200	5000
Lithium	7439932	10	400

Metals [11]	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg
Magnesium	7439954	1000	4000
Manganese [12]	7439965	50	1000
Molybdenum	7439987	50	1000
Nickel [12]	7440020	20	1000
Selenium	7782492	5	200
Silver	7440224	[0.2]	[100]
Sodium	7440235	1000	10000
Strontium	7440246	1000	5000
Thallium	7440280	2	500
Thorium	7440611	10	1000
Vanadium	7440622	4	1000
Zinc [12]	7440666	50	1000

Contaminants	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods for Lead[11] See MDEQ Laboratory SOP #213
Lead, Total [12]	7439921	3	1000	Report as Lead, Total
Lead, Fine Fraction [13]	PB_FINE	-----	1000	Report as Lead, Fine Fraction
Lead, Coarse Fraction [13]	PB_COARSE	-----	1000	Report as Lead, Coarse Fraction
Contaminants				**Designated Methods**
Chromium VI	18540299	10	2000	7199 (waters) 3060A/7199 (soils)
Mercury, Total [14,15]	7439976	0.001	[50]	1669/1631 [16] 6000 & 7000 245.7 200.8
Metals by XRF				
Instrument Specific	Various	-----	Varies	6200[17]

Contaminants	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods
DRO and GRO [18]				
Diesel Range Organics (DRO)	DRO	100	4000	Wisconsin Modified DRO
Gasoline Range Organics (GRO)	GRO	200	4000	Wisconsin Modified GRO
Carbonyls				
Acetaldehyde	75070	100	2500	8315A
Formaldehyde	50000	100	2000	8315A

TABLE 1. TARGET DETECTION LIMITS AND DESIGNATED ANALYTICAL METHODS

Contaminants	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods
Glycols				Use water extracts for soils
Triethylene Glycol	112276	4,000	50,000	8015C
Ethylene Glycol	107211	10,000	10,000	8015C 8430
Propylene Glycol	57556	10,000	50,000	8015C 8430
Dissolved Gases In Waters [19]				
Methane [19]	74828	500	-----	Methods: RSKSOP-175 and Isotec Method
Ethane	76017			
Ethylene	75218			
Nitrous oxide	10024972			
Soil Gases [19]			**Soil Gas TDL %**	
Methane[19]	74828	-----	0.005 (50 ppm)	Modified EPA Method 8015B, EPA Method 8015B, EPA Method TO-3, or ASTM 3416M (EPA 3C), Field methods discussed in Operational Memorandum No. 6.
Soil Gases (except methane)	Various	-----	Varies	Laboratory Methods: TO Air Methods Field Sampling and Analysis: D5314 – 92

Polynuclear Aromatics (PNAs) [20]	CAS/ID	Water TDL GC/MS ug/L	Soil TDL GC/MS ug/Kg	Designated Methods
Acenaphthene	83329	5	330	8270C (SIM) 8310
Acenaphthylene	208968	5	330	8270C (SIM) 8310
Anthracene	120127	5	330	8270C (SIM) 8310
Benzo(a)anthracene	56553	1	330	8270C (SIM) 8310
Benzo(b)fluoranthene	205992	1	330	8270C (SIM) 8310
Benzo(k)fluoranthene	207089	[1]	330	8270C (SIM) 8310
Benzo(ghi)perylene	191242	[1]	330	8270C (SIM) 8310
Benzo(a)pyrene	50328	[1]	330	8270C (SIM) 8310
2-Chloronaphthalene	91587	5	330	8270C (SIM) 8310 8260B
Chrysene	218019	1	330	8270C (SIM) 8310
Dibenzo(ah)anthracene	53703	[2]	330	8270C (SIM) 8310
Fluoranthene	206440	1	330	8270C (SIM) 8310
Fluorene	86737	5	330	8270C (SIM) 8310
Indeno(1,2,3-cd)pyrene	193395	[2]	330	8270C (SIM) 8310
2-Methylnaphthalene	91576	5	330	8270C (SIM) 8310 8260B 8261
Phenanthrene	85018	2	330	8270C (SIM) 8310
Pyrene	129000	5	330	8270C (SIM) 8310

TABLE 1. TARGET DETECTION LIMITS AND DESIGNATED ANALYTICAL METHODS

Contaminants	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods
Nitrosoamines				
N-Nitrosodi-n-propylamine	621647	[5]	[330]	8270C 8261 8070
N-Nitrosodimethylamine	62759	5	330	8270C 8261 8070
N-Nitrosodiphenylamine	86306	5	330	8270C 8261 8070
Benzidines				
Benzidine[21]	92875	[0.3]	[1000]	605 (Waters) 8270C (Ion Trap) (SIM)
3,3'-Dichlorobenzidine[21]	91941	[0.3]	[2000]	605 (Waters) 8270C (Ion Trap) (SIM)

Contaminants	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods
Acid Extractables (Phenols)				
2-Chlorophenol	95578	10	330	8270C 8041A
3-Chlorophenol	108430	10	330	8270C 8041A
4-Chloro-3-methylphenol	59507	5	280	8270C 8041A
2,4-Dichlorophenol	120832	10	330	8270C 8041A
2,6-Dichlorophenol	87650	5	330	8270C 8041A
2,3-Dimethylphenol	526750	5	330	8270C 8041A
2,4-Dimethylphenol	105679	5	330	8270C 8041A
2,6-Dimethylphenol	576261	4	[330]	8270C 8041A
3,4-Dimethylphenol	95658	5	[330]	8270C 8041A
3,5-Dimethylphenol	108689	5	330	8270C 8041A
2,4-Dinitrophenol	51285	25	<u>830</u>	8270C 8041A
2-Methyl-4,6-dinitrophenol	534521	[20]	<u>[830]</u>	8270C
Methylphenols [22]	1319773	30	1000	8270C
2-Methylphenol [22]	95487	10	330	8270C
3-Methylphenol [22]	108394	10	330	8270C
4-Methylphenol [22]	106445	10	330	8270C
2-Nitrophenol	88755	5	330	8270C 8041A
3-Nitrophenol	554847	20	<u>830</u>	8270C 8041A
4-Nitrophenol	100027	25	<u>830</u>	8270C 8041A
Pentachlorophenol [21, 23]	87865	1	20	8151A 515.1 515.2 8041A 8270C (SIM)
Phenol	108952	5	330	8270C 8041A
2,4,5-Trichlorophenol	95954	5	330	8270C 8041A
2,4,6-Trichlorophenol	88062	4	330	8270C 8041A

TABLE 1. TARGET DETECTION LIMITS AND DESIGNATED ANALYTICAL METHODS

Contaminants	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods
Semivolatiles				
Acetophenone	98862	5	330	8270C
Aniline[21]	62533	4	[330]	8270C 8131 8270C (SIM) 8261
Azobenzene	103333	2	200	8270C
Benzal Chloride	98873	10	330	8270C
Benzoic acid	65850	50	3300	8270C
Benzotrichloride	98077	0.1	20	8121
Benzyl Alcohol	100516	50	3300	8270C
Bis(2-chloroethoxy)ethane	112265	5	330	8270C
Bis(2-chloroethoxy)methane	111911	5	330	8270C
Bis(2-chloroethyl)ether	111444	1	100	8270C 8430
Bis(2-chloroisopropyl) ether	108601	5	330	8270C
Bis(2-ethylhexyl)phthalate	117817	5	330	8270C 8061A
4-Bromophenyl phenylether	101553	5	330	8270C
Butyl benzyl phthalate	85687	5	330	8270C 8061A
Caprolactam	105602	10	330	8270C
Carbazole	86748	**[10]**	330	8270C
4-Chloroaniline	106478	10	330	8270C 8131
2-Chloronaphthalene	91587	5	330	8270C 8121 8310
4-Chlorophenyl phenylether	7005723	5	330	8270C
Dibenzofuran	132649	4	330	8270C
Dicyclohexyl phthalate	84617	5	330	8270C 8061A
Di(2-ethylhexyl)adipate	103231	5	330	8270C 8061A
Diethyl phthalate	84662	5	330	8270C 8061A
Dimethyl phthalate	131113	5	330	8270C 8061A
Di-n-butyl phthalate	84742	5	330	8270C 8061A
Di-n-octyl phthalate	117840	5	330	8270C 8061A
1,3-Dinitrobenzene	99650	5	330	8270C 8095
2,4-Dinitrotoluene	121142	5	330	8270C 8330A 8095
2,6-Dinitrotoluene	606202	5	330	8270C 8330A 8095
1,2-Diphenylhydrazine	122667	5	330	8270C
Hexachlorobenzene (C-66)[21]	118741	0.2	330	8121 8270C – Ion Trap - (SIM)

TABLE 1. TARGET DETECTION LIMITS AND DESIGNATED ANALYTICAL METHODS

Contaminants	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods
Semivolatiles				
Hexachlorobutadiene (C-46) [21, 24]	87683	0.05	50	8121 8081B 8270C (SIM) 8261
Hexachloroethane	67721	5	300	8270C 8121
Hexachlorocyclopentadiene (C-56)	77474	5	330	8270C 8121
Isophorone	78591	5	330	8270C
4,4'-Methylene-bis-2-chloroaniline	101144	1	500	8270C
2-Methylnaphthalene	91576	5	330	8270C 8260B 8310
2-Nitroaniline	88744	25	830	8270C 8131
3-Nitroaniline	9909	25	830	8270C 8131
4-Nitroaniline	100016	25	830	8270C 8131
Nitrobenzene	98953	3	330 [25]	8270C 8330A 8095
Octachlorocyclopentene	706785	5	330	8270C
Pentachlorobenzene	608935	**[5]**	330	8270C 8121
Pentachloronitrobenzene	82688	20	330	8270C 8081B
Pyridine	110861	**[20]**	330	8270C 8261 8015C
1,2,3,4-Tetrachlorobenzene	634662	5	330	8270C 8121
1,2,3,5-Tetrachlorobenzene	634902	5	330	8270C 8121
1,2,4,5-Tetrachlorobenzene	95943	2	330	8270C 8121
p-Toluidine	106490	10	**[660]**	8270C

Contaminants	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods See Op Memo 2, Attachment 6 [26]
Volatiles				
Acetone [27]	67641	50	1000	8260B 8261
Acetonitrile [27]	75058	50	2500	8260B 8261 8033
Acrylamide	79061	0.5	-----	8032A 8316
Acrylonitrile	107131	2	**[{100}]**	524.2 8260B 8261 8031 8316
Acrolein	107028	20	{250}	8260B 8261 8316
Benzyl Chloride	100447	5	{150}	8260B 8121
Benzene	71432	1	50	8260B 8261 8021B
Bromobenzene	108861	1	100	8260B 8021B
Bromochloromethane	74975	1	100	8260B 8261 8021B
Bromomethane (Methyl bromide)	74839	5	{200}	8260B 8261 8021B

TABLE 1. TARGET DETECTION LIMITS AND DESIGNATED ANALYTICAL METHODS

Contaminants	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods
Volatiles				
2-Butanone (MEK)	78933	25	750	8260B 8261 8021B
n-Butyl Acetate	123864	10	250	8260B
n-Butyl Alcohol	71363	800	4400	8260B [28] 8015C
n-Butylbenzene	104518	1	50	8260B 8261 8021B
s-Butylbenzene	135988	1	50	8260B 8261 8021B
t-Butylbenzene	98066	1	50	8260B 8261 8021B
Carbon Disulfide	75150	5	250	8260B 8261
Carbon Tetrachloride	56235	1	50	8260B 8261 8021B
Chlorobenzene	108907	1	50	8260B 8261 8021B
Chloroethane	75003	5	250	8260B 8261 8021B
2-Chloroethylvinyl ether [29]	110758	10	5000	8260B
Chloromethane	74873	5	250	8260B 8261 8021B
2-Chlorotoluene	95498	5	50	8260B 8261 8021B
4-Chlorotoluene	106434	5	50	8260B 8261 8021B
Cyclohexanone	108941	50	2500	8260B 8261 8315A
1,2-Dibromo-3-chloropropane[21]	96128	0.2	**[{10}]**	8011 504.1 8260B 8081B (SIM)
Dibromomethane	74953	5	250	8260B 8261 8021B
1,2-Dichlorobenzene	95501	1	100	8260B 8261 8021B 8121
1,3-Dichlorobenzene	541731	1	100	8260B 8261 8021B 8121
1,4-Dichlorobenzene	106467	1	100	8260B 8261 8021B 8121
1,4-dichloro-2-butene, trans	764410	1	50	8260B 8261 8021B
Dichlorodifluoromethane	75718	5	250	8260B 8261 8021B
1,1-Dichloroethane	75343	1	50	8260B 8261 8021B
1,2-Dichloroethane	107062	1	50	8260B 8261 8021B
1,1-Dichloroethylene	75354	1	50	8260B 8261 8021B
1,2-Dichloroethylene, cis	156592	1	50	8260B 8261 8021B
1,2-Dichloroethylene, trans	156605	1	50	8260B 8261 8021B
1,2-Dichloropropane	78875	1	50	8260B 8261 8021B
2,2-Dichloropropane	594207	1	50	8260B 8261 8021B
1,3-Dichloropropane	142289	1	50	8260B 8261 8021B
1,1-Dichloropropene	563586	1	50	8260B 8261 8021B

TABLE 1. TARGET DETECTION LIMITS AND DESIGNATED ANALYTICAL METHODS

Contaminants	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods
Volatiles				
1,3-Dichloropropene [30]	542756	1	100	8260B 8261 8021B
1,3-Dichloropropene, cis	10061015	1	50	8260B 8261 8021B
1,3-Dichloropropene, trans	10061026	1	50	8260B 8261 8021B
1,3-Diethylbenzene	141935	1	150	8260B
Diethyl ether [27]	60297	10	200	8260B 8015C
Diethoxymethane	462953	10	500	8260B
1,4-Dioxane[21]	123911	1	<u>500</u>	8260B [28] 8261 1624 (SIM)
Epichlorohydrin	106898	**[5]**	{100}	8260B
Ethylbenzene	100414	1	50	8260B 8261 8021B
Ethylene Dibromide[29]	106934	0.05	**[{20}]**	8011 504.1 8260B 8261
Ethylene Oxide	75218	200	10000	8260B 8015B
2-Hexanone	591786	50	2500	8260B 8261 8021B
Isobutyl Alcohol	78831	1000	4400	8260B 8261 8015C
Isopropyl Alcohol	67630	400	4400	8260B [28] 8015C
Isopropylbenzene	98828	5	250	8260B 8261 8021B
p-Isopropyl toluene (p-Cymene)	99876	5	100	8260B 8261 8021B
Methyl Alcohol [31]	67561	400	4400	8260B [28] 8015C
4-Methyl-2-pentanone (MIBK) [27]	108101	50	2500	8260B 8261 8021B
Methylene Chloride [27]	75092	5	{100}	8260B 8261 8021B
Methyl iodide	74884	1	100	8260B
Methylcyclopentane	96377	50	2500	8260B
Naphthalene[21]	91203	5	330	8260B 8261 8270C (SIM) 8310
Pentane	109660	100	5000	8260B
n-Propyl benzene	103651	1	100	8260B 8261 8021B
Styrene [29]	100425	1	50	8260B 8261 8021B
1,1,1,2-Tetrachloroethane	630206	1	100	8260B 8021B
1,1,2,2-Tetrachloroethane	79345	1	50	8260B 8261 8021B
Tetrachloroethylene	127184	1	50	8260B 8261 8021B
Tetrahydrofuran	109999	<u>90</u>	1000	8260B 8261
Tetranitromethane	509148	100	**[500]**	8260B
Toluene	108883	1	100	8260B 8261 8021B

TABLE 1. TARGET DETECTION LIMITS AND DESIGNATED ANALYTICAL METHODS

Contaminants	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods
Volatiles				
1,2,4-Trichlorobenzene	120821	5	330	8260B 8261 8021B
1,1,1-Trichloroethane	71556	1	50	8260B 8261 8021B
1,1,2-Trichloroethane	79005	1	50	8260B 8261 8021B
Trichloroethylene	79016	1	50	8260B 8261 8021B
Trichlorofluoromethane	75694	1	100	8260B 8261 8021B
1,1,2-Trichloro-1,2,2-trifluoroethane	76131	1	250	8260B
1,2,3-Trichloropropane	96184	1	100	8260B 8261 8021B
Trihalomethanes [32]		100	-----	8260B 8261
Dibromochloromethane	124481	5	100	8260B 8261 8021B
Chloroform	67663	1	50	8260B 8261 8021B
Bromodichloromethane	75274	1	100	8260B 8261 8021B
Bromoform	75252	1	100	8260B 8261 8021B
1,2,4-Trimethylbenzene	95636	1	100	8260B 8261 8021B
1,3,5-Trimethylbenzene	108678	1	100	8260B 8261 8021B
2,2,4-Trimethylpentane	540841	50	2500	8260B
Vinyl Acetate	108054	100	5000	8260B
Vinyl Chloride	75014	1	{40}	8260B 8261 8021B
Xylenes [33]	1330207	3	150	8260B 8261 8021B
m-Xylene	108383	1	50	8260B 8261 8021B
p-Xylene	106423	1	50	8260B 8261 8021B
o-Xylene	95476	1	50	8260B 8261 8021B
Oxygenates [31]				**Designated Methods** [28]
t-Butyl alcohol (TBA)	75650	50	2,500	8260B
Di-isopropyl ether (DIPE)	108203	5	250	8260B
Ethyl(tert)butylether (ETBE)	637923	5	250	8260B
Ethyl alcohol	64175	1,000	2,500	8260B 8015C
Methanol	67561	400	4400	8260B 8015C
Methyl(tert)butylether (MTBE)	1634044	5	250	8260B
Tertiaryamylmethylether (TAME)	994058	5	250	8260B
Carbamates				
Aldicarb	116063	2	50	531.1 8318A
Aldicarb Sulfone [34]	1646884	2	**[200]**	531.1 8318A
Aldicarb Sulfoxide [34]	1646873	2	**[200]**	531.1 8318A

TABLE 1. TARGET DETECTION LIMITS AND DESIGNATED ANALYTICAL METHODS

Contaminants	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods
Carbamates				
Carbaryl	63252	20	200	531.1 8318A 8270C
Carbofuran	1563662	40	200	531.1 8318A
Diuron	300541	1	500	632 8321B 8325
Linuron	330552	0.1	-----	632
Oxamyl	23135220	100	1000	531.1 8318A
Acid Herbicides				
Dacthal metabolites [35]	DACMET	1	-------	8151A 515.1 515.2 515.4
Dalapon	75990	10	500	8151A
2,4-Dichlorophenoxyacetic acid	94757	10	200	8151A
Dicamba	1918009	1	50	8151A
Dinoseb	88857	**[1]**	**[200]**	8151A 8041A
2-Methyl-4-chlorophenoxyacetic acid (MCPA)	94746	5	300	8151A
MCPP	93652	5	300	8151A
Silvex (2,4,5-TP)	93721	30	300	8151A
Picloram	1918021	40	500	8151A
2,4,5-T	93765	10	500	8151A
Chlorinated Pesticides				
Alachlor	15972608	1	20	8081B 8270C 525.2 507
Aldrin	309002	**[0.01]**	20	8081B
Chlordane [36]	57749	2	30	8081B
Chlorpyrifos, ethyl	2921882	**[2]**	**[100]**	8081B 8141B
4,4'-DDD [37]	72548	0.1	20	8081B
4,4'-DDE [37]	72559	0.1	20	8081B
4,4'-DDT	50293	**[0.02]**	20	8081B
Dacthal	1861321	5	100	8081B 1656 608.2
Dichloran (2,6-Dichloro-4-nitroaniline)	99309	0.01	0.1	608.2
Dieldrin	60571	**[0.02]**	20	8081B
Endosulfan [38]	115297	0.03	20	8081B
Endosulfan I	959988	0.03	20	8081B
Endosulfan II	33213659	0.03	20	8081B
Endosulfan Sulfate	1031078	0.05	20	8081B

TABLE 1. TARGET DETECTION LIMITS AND DESIGNATED ANALYTICAL METHODS

Contaminants	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods
Chlorinated Pesticides				
Endrin	72208	0.02	20	8081B
Endrin Aldehyde	7421934	0.02	20	8081B
Endrin Ketone	53494705	0.02	20	8081B
Heptachlor	76448	**[0.01]**	20	8081B
Heptachlor epoxide	1024573	0.01	20	8081B
Hexabromobenzene	87821	0.02	100	8081B
alpha-Hexachlorocyclohexane (BHC)	319846	0.05	<u>10</u>	8121 8081B
beta-Hexachlorocyclohexane (BHC)	319857	0.02	20	8081B 8121
delta-Hexachlorocyclohexane (BHC)	319868	0.05	20	8081B 8121
Lindane (gamma-BHC)	58899	0.03	**[20]**	8081B 8121
Methoxychlor	72435	0.5	50	8081B
Mirex	2385855	**[0.02]**	50	8081B
Propachlor	1918167	50	200	8081B
Toxaphene	8001352	**[1]**	170	8081B
3-Trifluoromethyl-4-nitrophenol	88302	50	1000	8081B
tris(2,3-Dibromopropyl) phosphate	126727	**[10]**	330	8081B
Organophosphorus				
Atrazine	1912249	3	<u>50</u>	8141B 8270C 619 507
Cyanazine	21725462	2	<u>200</u>	8141B 629
Diazinon	333415	1	50	8141B 507
Dichlorvos	62737	1	**[50]**	8141B 507
Disulfoton	298044	1	50	8141B 507
EPTC	759944	3	100	8141B 507
Fonofos	944229	5	100	8141B 622.1
Molinate	2212671	2	100	8141B 507
Methyl parathion	2980000	1	40	8141B
Metolachlor	51218452	10	200	507 551.1
Metribuzin	21087649	0.1	10	507 551.1 1656
Prometon	1610180	50	200	507 619
Propazine	139402	100	2000	507 619
Simazine	122349	4	80	8141B 507 525.2 619 1656
Terbacil	5902512	20	-----	8141B 507
Triphenylphosphate	115866	10	500	8141B
Terbufos	13071799	5	-----	8141B 507

TABLE 1. TARGET DETECTION LIMITS AND DESIGNATED ANALYTICAL METHODS

Contaminants	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods
Specific Pesticides				
Clopyralid	1702176	1	20	PAM II ACR 75.6 ACR 86.1 547 8151A
Diallate	2303164	0.5	20	1618 1656 8081B
Diquat	85007	20	-----	549
Endothall	145733	100	-----	548
Glyphosate	1071836	100	1000	547 SM6651
Aminomethylphosphoric acid (AMPA-Glyphosate metabolite)	AMPA	100	10,000	547 SM6651
Pendimethalin	40487421	10	200	1656
Tebuthiuron	34014181	100	2000	8321B
Triallate	2303175	50	2000	8270C
Trifluralin	1582098	30	200	8270C 8081B

PCB AND PBB Contaminants	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods
Polybrominated biphenyls (FireMaster)[39]	67774327	0.01	50	8081B 8082A
Polychlorinated biphenyls (PCBs)[40]	1336363	[0.2]	330	8082A 8270C
Aroclor (unspecified)[41]	1267792	-----	-----	8082A 8270C
Aroclor 1016	12674112	-----	-----	8082A 8270C
Aroclor 1221	11104282	-----	-----	8082A 8270C
Aroclor 1232	11141165	-----	-----	8082A 8270C
Aroclor 1242	53469219	-----	-----	8082A 8270C
Aroclor 1248	12672296	-----	-----	8082A 8270C
Aroclor 1254	11097691	-----	-----	8082A 8270C
Aroclor 1260	11096825	-----	-----	8082A 8270C
Aroclor 1262	37324235	-----	-----	8082A 8270C
Aroclor 1268	11100144	-----	-----	8082A 8270C
Polychlorinated biphenyls congeners	Various	-----	-----	1668

Dioxins & Furans[42] Contaminants	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746016	[0.00001]	0.001	8290A 1613
2,3,7,8-Tetrabromodibenzo-p-dioxin	50585416	0.0001	0.01	8290A 1613 (Lab specific procedures)

TABLE 1. TARGET DETECTION LIMITS AND DESIGNATED ANALYTICAL METHODS

Polybrochlorinated and polybrominated diphenyl ethers	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Methods
Decabromodiphenyl ether	1163195	10	330	8270C1614
Polybrominated diphenyl ethers	Various		----	1614

Explosives	CAS/ID	Water TDL ug/L	Soil TDL ug/Kg	Designated Method
2-Amino-4,6-dinitrotoluene (2-Am-DNT)	35572782	1	50	8095
4-Amino-2,6-dinitrotoluene (4-AM-DNT)	1946510	1	50	8095
3,5-Dinitroaniline (3,5-DNA)	618871	1	50	8095
1,3-Dinitrobenzene (1,3-DNB)	99650	1	50	8095
2,4-Dinitrotoluene (2,4-DNT)	121142	1	50	8095
2,6-Dinitrotoluene (2,6-DNT)	606202	1	50	8095
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121824	1	50	8095
Nitrobenzene (NB)	98953	5	50	8095
Nitroglycerine (NG)	55630	5	50	8095
2-Nitrotoluene (2-NT)	88722	5	50	8095
3-Nitrotoluene (3-NT)	99081	5	50	8095
4-Nitrotoluene (4-NT)	99990	5	50	8095
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691410	10	50	8095
Pentaerythritoltetranitrate (PETN)	78115	5	50	8095
1,3,5-Trinitrobenzene (1,3,5-TNB)	99354	1	50	8095
2,4,6-Trinitrophenylmethylnitramine (Tetryl)	479458	1	50	8095
2,4,6-Trinitrotoluene (2,4,6-TNT)	118967	1	50	8095

Parameter	CAS/ID	Water TDL MFL	Soil TDL %	Designated Method
Asbestos	1332214	7	**[1]**	100.1 [43]

Parameter	CAS/ID	Designated Methods
Acute Toxicity	ACUTE	EPA-821-R-02-012
Chronic Toxicity	CHRONIC	EPA-821-R-02-013
Organic Carbon [44]	OC	Waters: 415.3 [45] Soils: Walkley-Black. [46] Total Organic Carbon [47]
Soil Bulk Density	SBD	ASTM Methods. [48] D2937-94
Soil Vapor Permeability	SVP	ASTM 1990 Methods D5126-90 and D5084-90

Abbreviations used in Table 1:

GC/MS: Gas chromatography with mass spectrum confirmation.
ICP/ES: Inductive coupled plasma emission spectroscopy.
SIM: Selected/single ion monitoring.
ICP/MS: Inductive coupled plasma with mass spectrometry detection.
MFL: Million fibers per liter (MFL) greater than 10 micrometer.
pH: Acidity as measured with pH meter.
GSI: Groundwater surface water interface.

Notations in Table 1:

- The TDLs in bold type and enclosed with **[ ]** brackets indicate that the contaminant's TDL is higher than the most restrictive criteria.
- For volatile organics, TDLs enclosed with **{ }** brackets indicate that the low level soil method may be required to reach a risk-based criteria. Check with the laboratory to determine if risk-based criteria can be reached for methanol-preserved samples, to determine if the low level method must be used.
- Contaminants listed in italicized format indicate that analysis is not available from the MDEQ laboratory.
- Underlined TDLs indicate the TDL was lowered from the previous operational memorandum.

Table 1 Footnotes:

1. The analysis using ion chromatography is not performed routinely by environmental laboratories. Arrangements for laboratories to perform this analysis must be made well in advance of sampling.
2. The bottle shake procedures, using reagent water, can be used for extraction of soil fluoride. If interferences are encountered, distillation procedures must be used. Colorimetric methods for the measurement of fluoride cannot be used.
3. Analysis of formate is used to determine compliance with formic acid cleanup criteria.
4. Hardness results must be calculated using separate determinations of calcium and magnesium and appropriate procedures for determining metals in SW-846. Hardness results determined by titration methods or other means than from calcium and magnesium results cannot be used for purposes of Part 201 or Part 213. No TDLs are needed because the methods available for metals can determine calcium and magnesium at any levels expected in surface and groundwaters.
5. Soil samples for total phosphorus must be digested using Kjeldahl or similar digestion techniques. See Association of Official Analytical Chemists 957.18
6. Soil sulfate analysis: Add to 5 g soil, 20 ml of extracting solution, 0.5N Ammonium Acetate/0.25N Acetic Acid in water mixture, extract for one hour on a mechanical shaker, filter on 42 Whatman ™ filter.
7. R 299.5750 footnote (P) requires, amenable cyanide or OIA 1677 methods to quantify cyanide concentrations for compliance with all groundwater criteria, and total cyanide or OIA 1677 methods to quantify cyanide concentrations for compliance with soil criteria. Method OIA 1677 is the preferred method for both waters and soils. (See Cyanide Information Sheet) The standard TDL for total cyanide in soils, in the methods provided, is 200 ug/Kg. The 100 ug/Kg TDL is applicable for site assessment and site investigation, and the total cyanide method is used with appropriate leaching procedures (See RRD Operational

TABLE 1. ABBREVIATIONS AND FOOTNOTES

Memorandum No. 2, Attachment 2). A TDL of 200 ug/Kg for cyanide may be used for response activities under Part 201 or Part 213 when the GSI pathway is appropriately documented to be not relevant.

8. The concentrations of all potential sources of nitrogen in groundwater and soils must be added together and compared to the nitrate drinking water criteria and soils protective of drinking water criteria. (See R299.5750 footnote(N)). All potential sources of nitrogen may be determined as elemental nitrogen in waters and soils provided the TDLs for nitrate are met. Several instruments and methods are available. Prior approval must be obtained from the MDEQ for use of specific methods to measure elemental nitrogen. Approval will be based on a review of the quality control and site-specific factors. For an example of the quality control required, see Method 440.0, Determination of Carbon and Nitrogen in Sediments and Particulates of Estuarine/Coastal Waters Using Elemental Analysis, Carl F. Zimmermann, Carolyn W. Keefe, University of Maryland System Center for Environmental Estuarine Studies, Chesapeake Biological Laboratory Solomns, MD 20688-0038 and Jerry Bashe, Technology Applications, Inc., 26 W. Martin Luther King Drive, Cincinnati, OH 45219, Revision 1.4, September 1997, National Exposure Research Laboratory, Office of Research and Development, U.S.EPA, Cincinnati, Ohio 45268. Other methods may be proposed.
9. Soil Ammonia: Air dry soil; do not heat. Soil ammonia must be distilled from soils. Standard Methods 4500 and EPA Methods 350.2 or 350.3, modified for soils can be used. Soil ammonia cannot be determined using extraction procedures.
10. Nitrate/nitrite, Reference: Methods of Soil Analysis, Part 2, Number 9 in the Agronomy Series, 1982. Extraction of soils for exchangeable nitrate/nitrite. Extraction can be accomplished by extraction of 3 g soil with 30 ml of 2M KCl for 30 minutes. Filter on 42 Whatman ™ filter.
11. The methods designated for analyses of metals include the methods in SW-846 (Methods 6000 & 7000 series), and Methods 200.7, 200.8 approved by the U.S. EPA for waters. ICP/MS procedures 6020 and 200.8 are preferred for waters analyses. Metals digestion procedures that allow recoverable metals to be determined must be used. The U.S. EPA Method 200.2, Sample Preparation Procedure for Spectrochemical Determinations of Total Recoverable Elements, Rev 2.8, is preferred for soils.
12. Criteria for the GSI pathway are based upon the hardness and pH of the receiving waters. See R 299.5750 footnote (G) for additional information.
13. Laboratories must determine lead concentrations in both the fine and coarse soil fractions when possible, and calculate total lead based on the lead concentrations in each fraction taking into consideration the relative weights of each fraction. When it is not possible to separate out any fraction, total lead must be determined and the appropriate project manager immediately informed of the affected samples. If upon sieving, the weights of any of the fractions are too small for sampling, lead analysis must be conducted on that fraction with sufficient sample and total lead should be conducted on a separate aliquot of the sample. The appropriate project manager must be immediately informed of the situation, and advised on any options that can be exercised, such as determining the lead in the sample available and qualifying the results. The MDEQ Laboratory SOP #213 provides appropriate procedures for sample preparation by the laboratory. The concentration of lead in each soil fraction should be compared to the lead direct contact criteria. The concentration of lead in the fine fraction should be compared to the lead particulate inhalation criteria. The total lead concentration should be compared to the remaining lead

TABLE 1. ABBREVIATIONS AND FOOTNOTES

soil criteria. Additional guidance is available in RRD Operational Memorandum No. 2, Attachment 5.

14. R 299.5750 footnote (Z) notes that generic cleanup criteria are based upon the toxicity of different species of mercury for different exposure pathways. The footnote allows comparison of generic criteria to species specific analytical data only if sufficient facility characterization has been conducted to rule out the presence of other species of mercury. Species specific analytical methods are not included in this document. Any proposal to use species specific methods requires MDEQ approval.
15. For response activities under Part 201 and Part 213, if the GSI pathway has been appropriately documented to be not relevant, a water TDL of 0.2 ug/L may be used.
16. The GSI criterion is a total mercury value and must be compared to total mercury analytical data. Low level mercury analysis (method 1631) must be used for waters. Low level mercury sampling specifications are provided in RRD Operational Memorandum No. 2, Attachment 7.
17. The reliability of XRF measurements are highly dependent upon the soil characteristics, mode of operation, training of personnel operating the instrument, and other factors. Results must be considered as screening measurements and cannot be used to establish compliance, unless coupled with adequate laboratory analysis to establish the validity of the results as quantitative.
18. Evaluation of Aesthetic Impacts – See RRD Operational Memorandum No. 2, Attachment 8 regarding application of these methods. GC/MS methods may be employed if it can be demonstrated that data is equivalent to the Wisconsin Modified Methods.
19. <u>Dissolved Gases in Waters:</u> Samples should be drawn from the wells using bladder pumps and collected in Tedlar bags. The use of bailers is not an acceptable method for sampling dissolved gases from wells. Care must be taken to keep gases dissolved until transferred to a suitable container. For the arrangement of a good sampling mechanism used to retain the pressure and keep gases dissolved, see the field sampling method "Collection of Ground Water Samples for Dissolved Gas Analysis" developed by Isotech Laboratories, Incl, 1308 Parkland Court, Champaign, IL 61821-1826, (217-398-3490). TDLs for gases other than methane are not provided. Consult the laboratories regarding reporting limits.
    <u>Methane in Soils:</u> See Operational Memorandum No. 6, Methane, for guidance on sampling and measuring methane in the field. Laboratory methods to analyze for light hydrocarbons include Method 3C designed for landfill gases, and various other methods using various types of detectors such as flame ionization. Since some labs may have separate canisters and instruments for trace and high levels of gases, the laboratory should be advised of the source of the methane and the expected levels in the samples in order to plan their analyses and provide suitable containers. Landfills are expected to contain percentage levels of methane, while ambient and indoor air may be expected to contain low parts per million or parts per billion.
    <u>Soil Gases other than methane:</u> Soil gas concentrations should be measured as a percent by volume in the soil gas, or converted to percent by volume (50 ppm = .005% by volume). Appropriate field sampling procedures in the ASTM Standard Method D 5314-92 should be used for sampling and analysis of soil gases other than methane. Other methods may be used if approved by the MDEQ. TDLs are only provided for methane. Consult with laboratories regarding reporting limits and other requirements for other gases. TO Air methods refer to various methods in Compendium of Methods for the Determination of Toxic

TABLE 1. ABBREVIATIONS AND FOOTNOTES

Organic Compounds in Ambient Air, U.S. EPA. Consult the laboratory regarding appropriate sampling procedures for specific methods.

20. GC/MS may be used anytime the laboratory's reporting limits for the method can measure the applicable criteria, including Ion Trap and single/selected ion monitoring (SIM). SIM can be used to lower the reporting limits for the PNAs about twenty times less than obtainable using full scan on the GC/MS.
21. When analyses of these are requested using GC/MS, SIM analyses must be conducted on all samples with no detects found in the full scan mode. Positive detects in the SIM mode should then be appropriately coded to indicate SIM analyses was conducted.
22. Isomer specific concentrations of 2-, 3-, and 4-, methylphenols must be added together for comparison to methylphenols criteria for pathways other than the GSI pathway. For the GSI pathway isomer specific concentrations should be compared to the following values: 2-methylphenol 82 ug/l; 3-methylphenol 71 ug/l; 4-methylphenol 25 ug/l.
23. For response activities under Part 201 and Part 213, if the GSI and the drinking water pathways have been appropriately documented to be "not relevant", then a water TDL of 20 ug/L and soil TDL of 800 ug/Kg may be used.
24. For response activities under Part 201 and Part 213, if the GSI pathway has been appropriately documented to be "not relevant", then a water TDL of 10 ug/L and soil TDL of 330 ug/Kg may be used.
25. This TDL applies only for response activities under Part 201 and Part 213, if the drinking water pathway has been appropriately documented to be not relevant. See the parameter group "Explosives" for the appropriate method for this compound for site assessment and site investigation. Aniline is a product of nitrobenzene degradation in waters and soils and should be included in the analytical scheme when possible.
26. Soil sampling collection and preservation specifications for volatiles including protocol for methanol preservation are contained in RRD Operational Memorandum No. 2, Attachment 6.
27. This is a common laboratory solvent. Cautious review is required of analytical results for laboratory blanks to assess compliance.
28. High temperature purging and/or isotope dilution procedures may be required.
29. This contaminant is a reactive compound which requires special sampling and holding time requirements.
30. The concentrations of the cis and trans isomers must be added and reported as 1,3-Dichloropropene.
31. These contaminants are oxygenates and may be found at sites where gasoline products were used.
32. Trihalomethanes refers to chloroform, bromodichloromethane, dibromochloromethane, and bromoform. The concentrations of all trihalomethanes must be added and compared to the criteria. (See R 299.5750 footnote (W)).
33. The concentrations of the m-, p-, and o- xylene isomers must be added and the total compared to the total xylenes criteria.
34. Aldicarb Sulfone and Aldicarb Sulfoxide are metabolites of Aldicarb.
35. The monoacid (CAS 887547) and diacid (CAS 2136790) metabolites of Dacthal are measured as one compound and compared to the criteria for Dactal (CAS 1861321).
36. For comparison to the criteria, isomer specific concentrations for trans-Chlordane, (CAS RN 5103719), and cis-Chlordane, (CAS RN 510374) must be reported separately and the sum of their concentrations reported as Chlordane, (CAS RN 57749). If compounds other than

TABLE 1. ABBREVIATIONS AND FOOTNOTES

cis and trans-Chlordane are used to calculate the chlordane concentration, report the concentrations of each separately and report Chlordane, (CAS RN 57749) using the guidance in Method 8081B for calculation. Some components of the mixture may have specific criteria, which must also be met.

37. 4,4'-DDD and 4,4'DDE are metabolites of DDT.
38. Isomer specific concentrations of Endosulfan I, (CAS 959988), and Endosulfan II, (CAS 33213659) must be added for comparison to Endosulfan criteria.
39. The term "Polybrominated biphenyls" listed in the rules and in this table (CAS 67774327) refers to a product used in Michigan, called Firemaster FF1. Firemaster FF1 consisted of several polybrominated biphenyls, the most prevalent being hexabrominated biphenyl (56%). Subsequently, cleanup criteria was established for waters and soils which applied to that product, and designated methods for the product were based on the concentrations of hexabrominated biphenyl. Recently the group of contaminants known as brominated biphenyl congeners have become a concern and it is necessary to distinguish between the product Firemaster FF1 and the individual brominated biphenyl congeners. Calibration and quantitation of FireMaster in samples should be accomplished by using technical brand FireMaster as the calibrant and quantitating using the procedures in method 8082 for calibrating Aroclor products. If the FireMaster technical product is not available, use the most dominant hexabromobiphenyl peak present in the FireMaster product as the calibrant, and report the concentrations found for that isomer as FireMaster.
40. Commercial products with specific mixtures of polychlorinated congeners were sold in the United States under product names beginning with Aroclor. The term in the table, Polychlorinated biphenyls (PCBs) refers to the total concentration of all Aroclor products found at a facility. The concentrations of the Aroclors found at a facility must be added together to obtain a total concentration, and the total concentration used for comparison to the criteria. (R 299.5750 footnotes (J) and (T)). Laboratories should report data below the reporting limits and above the method detection limits when possible, coded to indicate estimates.
41. When attempts are not successful to match the patterns of the Aroclor products with the pattern found in a sample, laboratories should report Aroclor (unspecified), (CAS 1267792), and its concentration determined using the Aroclor 1260 calibration.

TABLE 1. ABBREVIATIONS AND FOOTNOTES

42. The concentrations of polychlorinated and polybrominated dibenzodioxin and dibenzofuran isomers present at a facility, expressed as an equivalent concentration of 2,3,7,8-tetrachlorodibenzo-p-dioxin based on their relative potency must be added together Those isomers with non-zero TEF are provided in the table below. The toxicity equivalency of a specific dioxin, furan or PCB in a sample is calculated by multiplying its concentration by its respective TEF. The toxicity equivalencies must be added together to obtain a total toxic equivalency (TEQ) and the TEQ compared to the criteria for 2,3,7,8-tetrachlorodibenzo-p-dioxin. (R 299.5750 footnote (O)).

TOXICITY EQUIVALENT FACTORS FOR CHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

COMPOUND	TEF	COMPOUND	TEF
2,3,7,8-TCDD	1.0	2,3,4,7,8-PeCDF	0.5
1,2,3,7,8-PeCDD	1.0 (0.5)*	1,2,3,4,7,8-HxCDF	0.1
1,2,3,4,7,8-HxCDD	0.1	1,2,3,6,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDD	0.1	1,2,3,7,8,9-HxCDF	0.1
1,2,3,7,8,9-HxCDD	0.1	2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDD	0.01	1,2,3,4,6,7,8-HxCDF	0.01
1,2,3,4,6,7,8,9-OCDD	0.0001 (0.001)*	1,2,3,4,7,8,9-HxCDF	0.01
2,3,7,8-TCDF	0.1	1,2,3,4,6,7,8,9-OCDD	0.0001 (0.001)*
1,2,3,7,8-PeCDF	0.05		

* For comparing groundwater samples to GSI criteria, use the TEF in parentheses. (R 323.1209).

43. Bulk sampling requirements as designated by the laboratory chosen for the analysis must be used. Laboratories certified by various state and federal agencies for asbestos analysis should be used. MDEQ approved methods must be used. One procedure approved is: Method Number ID-191 Matrix: Bulk, 29 CFR, Part 1915, Occupational Safety and Health Standards for Shipyard Employment, Subpart Z, Toxic and Hazardous Substances, 1915.1001 App K, Polarized light microscopy of Asbestos – Non Mandatory, U.S. Department of Labor, Occupational Safety and Health Administration. For samples with more than 1 percent asbestos content in soils, or above 7 MFL in waters, additional information of the asbestos types may be confirmed using Transmission Electron Microscopy. One method approved for use is: CFR, Part 763, Subpart E, Appendix A, Interim Transmission Electron Microscopy Analytical Methods-Mandatory and Non Mandatory-and Mandatory Section to Determine Completion of Response Actions. For preparation of soils, see U.S. EPA, Region 1 – Office of Environmental Evaluation and Measurement, The Protocol for Screening Soil and Sediment Samples for Asbestos Content used by the U.S. EPA, Region 1 Laboratory.

TABLE 1. ABBREVIATIONS AND FOOTNOTES

44. Organic carbon and total organic carbon are different descriptions for the same parameter being determined, organic carbon. The following are requirements in the sampling and analysis for organic carbon.
    a) Results for organic carbon may not be used to calculate organic matter concentrations without prior approval from the MDEQ.
    b) Results for organic matter may not be used to calculate organic carbon concentrations without prior approval from the MDEQ.
    c) Soil samples must be representative of the soils at sites, from about six inches below the surface down to the mean annual depth of the water table, and representative of the soils based on heterogeneity.
    d) Soil vegetation should not be included with the soil samples as organic carbon results must represent that in the natural soil.
    e) Soil samples should not be taken from areas significantly impacted by contamination.
45. Method 415.3, "Determination of Total Organic Carbon and Specific UV Absorbance at 254 nm in Source Water and Drinking Water", Revision 1.0, June 2003, U.S. EPA, Office of Research and Development, U.S. EPA, Cincinnati, OH 45268, or an equivalent method, is recommended. Other methods can be used upon approval by the MDEQ and equivalency to the analysis and quality control as provided in method 415.3 will be the basis by which other methods are evaluated.
46. Walkley-Black methods measure the organic carbon in soils that is easily oxidized after removal of inorganic forms of carbon by acidification and heating. These methods are most appropriate for soils with less than 2 percent organic matter, and should not be used for soils with more than 6 percent organic matter.
47. Total organic carbon (TOC) methods generally refer to those methods that measure the organic carbon by ignition at high temperatures. See method 415.3 for guidance for waters. For soils, the following are minimum sampling and analysis requirements for these methods. Prior approval must be obtained from the MDEQ to use specific methods. Approval to use proposed methods will be based on a review for adequate quality control and application based on site specific factors.
    a) Instrument systems must be used that are capable of quantitatively determining organic carbon in the presence of inorganic forms of carbon, such as carbonate and bicarbonate.
    b) Methods must demonstrate capability to remove inorganic forms prior to measurements for organic carbon.
    c) Strong acids must be used to remove inorganic forms of carbon. Persulfate and hydrochloric acids are recommended.
    d) Methods that use a mixture of water and soil, and/or use methods designed for waters and/or wastes, are unacceptable.
    e) Methods that determine organic carbon by subtracting inorganic carbon measurements from total carbon measurements are unacceptable.
    f) Organic carbon must be reported as a percentage of the dry weight of the unacidified samples to the nearest 0.1% unit.
    g) TOC methods are most appropriate for soils with greater the 6 percent organic matter.

TABLE 1. ABBREVIATIONS AND FOOTNOTES

48. Soil bulk density is defined as the ratio of the mass of dry solids to the bulk volume of the soil occupied by those dry solids. The bulk volume includes the volume occupied by the soil solids and the pore spaces. The dry solids must be determined by drying the soil to constant mass in an oven at 105 ± 5 degrees centigrade. ASTM 1994, Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method, D2937-94, is the designated method for analysis of soil bulk density. Other ASTM methods may be acceptable when approved by the MDEQ and applied to the appropriate soils types, as provided in the individual methods.

TABLE 2. SOURCE DOCUMENTS FOR DESIGNATED ANALYTICAL METHODS

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, U.S. Environmental Protection Agency – Office of Solid Waste & Emergency Response, Edition 3 (SW-846) (http://www.epa.gov/epaoswer/hazwaste/test/8_series.htm)

Method	Title
3060A	Alkaline Digestion for Hexavalent Chromium
3550	Ultrasonic Extraction
5021A	Volatile Organic Compounds in Various Sample Matrices using Equilibrium Headspace Analysis
5035A	Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples
6000	SW-846 Manual, Chapter 3 and 6000 Series Methods
6200	Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment
7000	SW-846 Manual, Chapter 3 and 7000 Series methods
7196A	Chromium, Hexavalent (Colorimetric)
7199	Chromium, Hexavalent by Ion Chromatography
7473	Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry
7474	Mercury in Sediment and Tissue Samples by Atomic Fluorescence Spectrometry
7580	White Phosphorus by Solvent Extraction and Gas Chromatography
8011	1,2-Dibromoethane and 1,2-Dibromo-3-chloropropane by Microextraction and Gas Chromatography
8015C	Non-halogenated Organics Using GC/FID
8021B	Halogenated and Aromatic Volatiles by Gas Chromatography using Electrolytic Conductivity and Photoionization Detectors in Series: Capillary Column Technique
8031	Acrylonitrile by Gas Chromatography
8032A	Acrylamide by Gas Chromatography
8033	Method 8033, Acetonitrile by Gas Chromatography with Nitrogen-Phosphorus Detection
8041A	Phenols by Gas Chromatography
8061A	Phthalate Esters by Capillary Gas Chromatography With Electron Capture Detector (GC/ECD)
8081B	Organochlorine Pesticides and PCBs as Aroclors by GC Capillary Column Technique
8082A	Polychlorinated Biphenyls (PCBs) by Gas Chromatography
8121	Chlorinated Hydrocarbons by Gas Chromatography: Capillary Column Technique
8131	Aniline and Selected Derivatives by Gas Chromatography
8141B	Organophosphorus Pesticides by Gas Chromatography: Capillary Column Technique
8151A	Chlorinated Herbicides by GC Using Methylation or Pentafluorobenzylation, Derivation: Capillary Column Technique
8260B	Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS): Capillary Column Technique
8261	Volatile Organic Compounds by Vacuum Distillation in Combination with Gas Chromatography/Mass Spectrometry (VD/GC/MS)

TABLE 2. SOURCE DOCUMENTS FOR DESIGNATED ANALYTICAL METHODS

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, U.S. Environmental Protection Agency – Office of Solid Waste & Emergency Response, Edition 3 (SW-846)

Method	Title
8270C	Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry, (GC/MS): Capillary Column Technique
8270C Ion Trap	This reference is simply to point out that the Method 8270C above allows the use of the ion trap technology and may be needed to reach low detection limits.
8270C SIM	This reference is simply to point out that the selective ion procedure can be used in Method 8270C above and may be needed to reach low detection limits.
8290A	Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans, (PCDFs) by High-Resolution Gas Chromatograph/ High-Resolution Mass Spectrometry (HRGC/HRMS)
8310	Polynuclear Aromatic Hydrocarbons (GC/HPLC and UV or fluorescence detectors)
8315A	Determination of Carbonyl Compounds by HPLC
8316	Acrylamide, Acrylonitrile and Acrolein by High Performance Liquid Chromatography (HPLC)
8318A	N-Methylcarbamates by HPLC
8321B	Solvent Extractable Nonvolatile Compounds by HPLC/MS or UV Detection
8325	Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Particle Beam/Mass Spectrometry (HPLC/PB/MS)
8330A	Nitroaromatics and Nitramines by HPLC
8430	Analysis of Bis(2-chloroethyl) Ether and Hydrolysis Products by Direct Aqueous Injection GC/FT-IR (Gas Chromatography/Fourier Transform Infrared Spectrometer)
9010B	Total and Amenable Cyanide
9012	Total and Amenable Cyanide (Colorimetric, Automated UV)
9013	Cyanide Extraction Procedure for Solids and Oils
9014	Titrimetric and Manual Spectrometric Determinative Methods for Cyanide
9030	Acid-Soluble and Acid-Insoluble Sulfides
9034	Titrimetric Procedure for Acid-Soluble and Acid Insoluble Sulfides
9035	Sulfate (Colorimetric, Automated, Chloraniliate)
9036	Sulfate (Colorimetric, Automated, Methylthymol Blue, AA II)
9040C	pH Electrometric Measurement
9045C	Soil and Waste Ph
9056	Determination of Inorganic Anions by Ion Chromatography
9058	Determination of Perchlorate Using Ion Chromatography with Chemical Suppression Conductivity Detection
9070A	See Method 1664, Publication No.EPA-821-R-98-002
9071B	n-Hexane Extractable Material (HEM) for Sludge, Sediment, and Solid Samples
9212	Potentiometric Determination of Chloride in Aqueous Samples with Ion-Selective Electrode
9213	Potentiometric Determination of Cyanide in Aqueous Samples and Distillates with Ion-Selective Electrode
9214	Potentiometric Determination of Fluoride in Aqueous Samples with Ion-Selective Electrode

TABLE 2. SOURCE DOCUMENTS FOR DESIGNATED ANALYTICAL METHODS

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, U.S. Environmental Protection Agency – Office of Solid Waste & Emergency Response, Edition 3 (SW-846)

Method	Title
9215	Potentiometric Determination of Sulfide in Aqueous Samples and Distillates with Ion-Selective Electrode
9250	Chloride (Colorimetric, Automated Ferricyanide AAI)
9251	Chloride (Colorimetric, Automated Ferricyanide AAII)
9253	Chloride (Titrimetric, Silver Nitrate)

Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Athens, Georgia 30613

Method	Title
100.1	Analytical Method for Determination of Asbestos Fibers in Water

Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, Appendix A, Revised: July 1990

Method	Title
605	Benzidines

Methods for the Determination of Organic Compounds in Drinking Water & Supplement I, III, U.S. EPA, EMSL, Cincinnati, OH 45268, Edition: December 1988 and July 1990

Method	Title
502.2	Method 502.2, Volatile Organic Compounds In Water by Purge and Trap Capillary Column Gas Chromatography with Photoionization and Electrolytic Conductivity Detectors In Series
504.1	1,2-Dibromoethane (EDB) and 1,2-Dibromo-3-chloropropane (DBCP) in Water by Microextraction and Gas Chromatography
507	Determination of Nitrogen and Phosphorous-Containing Pesticides in Water by Gas Chromatography with a Nitrogen-Phosphorous Detector
515.1	Determination of Chlorinated Acids in Water by Gas Chromatography with an Electron Capture Detector
515.2	Determination of Chlorinated Acids in Water using Liquid-Solid Extraction and Gas Chromatography with an Electron Capture Detector
515.3	Determination of Chlorinated Acids in Water using Liquid-Solid Extraction and Gas Chromatography with an Electron Capture Detector (Stand alone Method)
515.4	Method 515.4, Determination of Chlorinated Acids in Drinking Water by Liquid-Liquid Microextraction, Derivatization, and Fast Gas Chromatography with Electron Capture Detection, Revision 1.0, April 2000
524.2	Method 524.2, Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry
525.2	Determination of Organic Compounds in Drinking Water by Liquid-Solid Extraction and Capilliary Column Gas Chromatography/Mass Spectrometry

TABLE 2. SOURCE DOCUMENTS FOR DESIGNATED ANALYTICAL METHODS

Methods for the Determination of Organic Compounds in Drinking Water & Supplement I, III, U.S. EPA, EMSL, Cincinnati, OH 45268, Edition: December 1988 and July 1990

Method	Title
531.1	Measurement of N-Methylcarbomoylzimes and N-Methylcarbamates in Water by Direct Aqueous Injection HPLC with Post Column Derivatization, Revision 3.1
547	Determination of Glyphosate in Drinking Water by Direct-Aqueous-Injection HPLC, Post-Column Derivatization, and Fluorescence Detection
548	Determination of Endothall in Drinking Water by Aqueous Derivatization, Liquid Solid Extraction, and Gas Chromatography with Electron-Capture Detection
549	Determination of Diquat and Paraquat in Drinking Water by Liquid-Solid Extraction and HPLC with Ultraviolet Detection
551.1	Determination of Chlorination Disinfection Byproducts, Chlorinated Solvents, and Halogenated Pesticides/Herbicides in Drinking Water by Liquid-Liquid Extraction and Gas Chromatography with Electron Capture Detection

EPA:USEPA Contract Laboratory Program Statement of Work for Inorganics Analysis and Classical Chemistry Parameters, Multi-Media, Multi-Concentration, ILM05.1, June 2001

Method	Title
CLP-CN	Exhibit D – Part D, Analytical Methods for Total Cyanide Analysis

U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology Engineering and Analysis Division (4303), 401 M Street SW, Washington, D.C.20460

Method	Title
Kelada-01	Kelada Automated Test Methods For Total Cyanide, Acid Dissociable Cyanide, And Thiocyanate, Revision 1.2
OIA-1677	Available Cyanide by Flow Injection, Ligand Exchange, and Amperometry, August 1999, EPA-821-R-99-013
200.2	Revision 2.8: Sample Preparation Procedure for Spectrochemical Determination of Total Recoverable Elements, October 1999, EPA-821-R-99-018
218.6	Revision 3.4, Determination Of Dissolved Hexavalent, Chromium In Drinking Water, Groundwater, and Industrial Wastewater Effluents by Ion Chromatography, October 1999, EPA-821-R-99-016
245.7	Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry, Draft, January 2001, EPA-821-R-01-008
1636	Determination of Hexavalent Chromium by Ion Chromatography, January 1996

EPA:Volatile/Semivolatile Organic Compounds by Isotope Dilution GC/MS, USEPA Office of Water Regulations and Standards, Ind. Tech. Div., Edition: June 1989

Method	Title
1624	Volatile Organic Compounds by Isotope Dilution GC/MS

TABLE 2. SOURCE DOCUMENTS FOR DESIGNATED ANALYTICAL METHODS

U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology Engineering and Analysis Division (4303), 401 M Street SW, Washington, D.C.20460

Method	Title
1630	Methyl Mercury in Water by Distillation, Aqueous Ethylation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry, August 1998
1631E	Revision E: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry
1631E (mod)	EPA-821-R-01-013, January 2001, Appendix to Method 1631 Total Mercury in Tissue, Sludge, Sediment, and Soil by Acid Digestion and BrCl Oxidation
1669	Method 1669, Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels, July 1996

U.S. Environmental Protection Agency, Office of Water(4304T), 1200 Pennsylvania Avenue, NW, Washington, D.C. 20460

Method	Title
EPA-821-R-00-002	Method 1668, Revision A, Chlorinated Biphenyl Congeners in Water, Soil, Sediment, and Tissue by HRGC/HRMS
EPA-821-R-02-012	Short Term Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition, October 2002
EPA-821-R-02-013	Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, Fourth Edition, October 2002.

Analytical Methods For the National Sludge Survey, US Environmental Protection Agency, Officer of Water (WH-585), Edition: September 1990

Method	Title
1613	Tetra-through Octa-Chlorinated Dioxins and Furans by Isotope Dilution HRGC/HRMS, Rev B
1618	Organo-Halide Pesticides, Organo-Phosphorus Pesticides, and Phenoxy Acid Herbicides by Wide Bore Capillary Column Gas Chromatography with Selective Detectors

Methods for Chemical Analysis of Water and Wastes, USEPA, EMSL, Cincinnati.OH 45268

Method	Title
160.1	Residue, Filterable (Gravimetric, Dried at 180°C)
200.7	ICP-AES Method for Trace Element Analysis of Water and Wastes
200.8	Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectrometry
300.1	The Determination of Inorganic Anions in Water by Ion Chromatography -
314	Method 314.0, Determination of Perchlorate in Drinking Water Using Ion Chromatography
325.1	Chloride (Colorimetric, Automated Ferricyanide, AAI)
325.2	Chloride (Colorimetric, Automated Ferricyanide, AAII)
340.1	Fluoride, Total
350.1	Nitrogen, Ammonia (Colorimetric, Automated Phenate)

TABLE 2. SOURCE DOCUMENTS FOR DESIGNATED ANALYTICAL METHODS

Methods for Chemical Analysis of Water and Wastes, USEPA, EMSL, Cincinnati.OH 45268

Method	Title
350.2	Nitrogen, Ammonia (Colorimetric; Titrimetric; Potentiometric – Distillation Procedure)
350.3	Nitrogen, Ammonia (Potentiometric, Ion Selective Electrode)
351.x	Kjeldahl Nitrogen
353.2	Nitrogen, Nitrate-Nitrite, Colorimetric, Automated, Cadmium Reduction
360.1	Oxygen, Dissolved, Membrane Electrode
360.2	Oxygen, Dissolved, Modified Winkler Full Bottle Technique
365.4	Phosphorous, Total (Colorimetric, Automated, Block Digester AA II)
375.1	Sulfate (Colorimetric, Automated, Chloranilate)
376.2	Sulfide (Colorimetric, Methylene Blue)
375.2	Sulfate (Colorimetric, Automated, Methylthymol Blue, AAII)
376.1	Sulfide, Titrimetric, Iodine

Standard Methods for the Examination of Water and Wastewater

Method	Title
SM6651	Glyphosate Herbicide
SM2340 B	Hardness by Calculation

Methods for the Determination of Nonconventional Pesticides in Municipal and Industrial Wastewater, USEPA Office of Water, Engineering and Analysis Division, WH-552, Edition: April 1992

Method	Title
1656	The Determination of Organo-Halide Pesticides in Municipal and Industrial Wastewater
608.1	The Determination of Organochlorine Pesticides in Municipal and Industrial Wastewater
608.2	The Determination of Certain Organochlorine Pesticides in Municipal and Industrial Wastewater
619	The Determination of Triazine Pesticides in Municipal and Industrial Wastewater
629	The Determination of Cyanazine in Municipal and Industrial Wastewater

Official Methods of Analysis, Association of Official Analytical Chemists, Edition: 15, 1990

Method	Title
983.01	Urea and Methyleneureas
957.18	Microdetermination of Phosphorus, Kjeldahl Digestion Method

Pharmaceutical Industry Pollutants, USEPA, Engineering and Analysis Division, EPA 821 B-94-001

Method	Title
1671	Volatile Organic Compounds Specific to the Pharmaceutical Manufacturing Industry By GC/FID

TABLE 2. SOURCE DOCUMENTS FOR DESIGNATED ANALYTICAL METHODS

Method

Walkley-Black Method

Instruments are available that utilize a form of the Walkley-Black digestion procedure. The following documents provide the original method and some modifications.

> Walkley, A., and Black., 1934. An examination of the Degtijareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Sci.37:29-38
> Walkley, A., 1947. A critical examination of a rapid method for determining organic carbon in soils: Effect of variations in digestion conditions and of inorganic soil constituents. Soil Sci.63:251-257
> Jackson, M.L.1958.Soil Chemical Analysis.214-221.
> Schollenberger, C.J.1927. A Rapid Approximate Method for Determining Soil Organic Matter. Soil Sci.24:65-68

USEPA Office of Research and Development, USEPA, Cincinnati, OH 45268

Method	Title
415.3	Determination of Total Organic Carbon and Specific UV Absorbance at 254 nm in Source Water and Drinking Water, Revision 1.0, June 2003

Methods of Soil Analysis

Keeney, D. R. and D. W. Nelson. 1987.

Nitrogen--Inorganic Forms, sec. 33-3, extraction of exchangeable ammonium, nitrate, and nitrite. pp.648-9. In A. L. Page et al., eds., **Methods of Soil Analysis: Part 2, Chemical and Microbiological Properties.** *Agronomy, A Series of Monographs*, no.9 pt.2, Soil Science Society of America, Madison, Wisconsin USA.

Modified Wisconsin Methods

Method	Title
Wisconsin Modified GRO	Method for Determining Gasoline Range Organics, Wisconsin DNR, September 1995, WDNR PUBL-SW-140
Wisconsin Modified DRO	Method for Determining Diesel Range Organics, Wisconsin DNR, September 1995, WDNR PUBL-SW-141

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, U.S. Environmental Protection Agency – Office of Solid Waste and Emergency Response, Edition 3

Method	Title
4030	Soil Screening for Petroleum Hydrocarbons by Immunoassay
4035	Soil Screening for Polynuclear Aromatic Hydrocarbons by Immunoassay

ASTM Standards, Americal Society of Testing Materials

Method	Title
D 5314-92	Standard Guide for Soil Gas Monitoring in the Vadose Zone

TABLE 2. SOURCE DOCUMENTS FOR DESIGNATED ANALYTICAL METHODS

Methane Procedures

Method	**Title**
RSKSOP-175	Standard Operating Procedure, Sample Preparation and Calculation for Dissolved Gas Analysis in Water Samples Using a GC Headspace Equilibration Technique, R.S. Kerr Environmental Research Laboratory, USEPA,1994.
IsoTech Laboratories Method	Collection of Ground Water Samples for Dissolved Gas Analysis, Isotech Laboratories, Inc., 1308 Parkland Court, Champaign, IL 61821-1826, (217-398-3490)
Method 3C	40 Code of Federal Regulations, Part 60, Appendix A, Method 3C – Determination of carbon dioxide, methane, nitrogen, and oxygen from stationary sources

Pesticide Analytical Methods (PAM), I and II

Method	**Title**
ACR 75.6	Pesticide Analytical Manual, U.S. Department of Health and Human Services, Public Health Service, Food and Drug Administration, Third Edition, Revised 1999.
ACR 86.1	Pesticide Analytical Manual, U.S. Department of Health and Human Services, Public Health Service, Food and Drug Administration, Third Edition, Revised 1999.

TABLE 3. CONTAMINANTS ADDED TO TDLs AND DESIGNATED ANALYTICAL METHODS LIST

Note: Some parameters in this group may be in Table 1 also. They are included in the table below to indicate an addition as a group.

Contaminant Group	Contaminant	CAS/ID	WATER TDL ug/L	SOIL TDL ug/Kg
Specific Contaminants	*Acetate*	ACETATE	1,000	20,000
	Asbestos	1332214	7 MFL	1 %
	Dissolved Oxygen	DO	80	-----
	Formate	FORMATE	1,000	20,000
	Perchlorate	14797730	3	-----
	Petroleum Hydrocarbon Material	PET_HYD	5,000	250,000
	pH	pH	-----	-----
	Total Dissolved Solids	TDS	10,000	----
Nitrogen Forms	Kjeldahl-N	TKN	50	1,000
	Nitrogen, Total (elemental)	7727379	100	1,000
Metals	Chromium III	16065831	10	2,000
	Lead, Coarse Fraction	7439921	3	1,000
	Lead, Fine Fraction	7439921	3	1,000
Glycols	Triethylene Glycol	112276	4,000	50,000
Volatiles	Trihalomethanes (group)	THM	100	-----
	Tetranitromethane	509148	100	500
Oxygenates	*Di-isopropyl ether (DIPE)*	108203	5	250
	Ethyl(tert)butylether (ETBE)	637923	5	250
	Tertiaryamylmethylether (TAME)	994058	5	250
Carbamates	Linuron	330552	0.1	-----
	Oxamyl	23135220	10	100
Acid Herbicides	*Dacthal metabolites*	DACMET	1	-----
Chlorinated Pest.	Endosulfan (group)	115297	0.03	20
Organophosphorus	Disulfoton	198044	1	50
	EPTC (s-ethyl-diproplythiocarbamate)	759944	3	100
	Molinate	2212671	2	100
	Terbacil	5902512	20	-----
	Triphenylphosphate	115866	10	500
	Turbofos	13071799	20	-----
Specific Pesticides	Aminomethylphosphoric acid (AMPA-Glyphosate metabolite)	AMPA	100	10,000
	Clopyralid	1702176	1	20
	Fonofos	944229	10	-----
	Metribuzin	21087649	0.1	10
PCB AND PBB	Aroclor (unspecified)	1267792	0.2	330
Soil Bulk Density	Soil Bulk Density	SBD	-----	-----

TABLE 3. CONTAMINANTS ADDED TO TDLs AND DESIGNATED ANALYTICAL METHODS LIST

Note: Some parameters in this group may be in Table 1 also. They are included in the table below to indicate an addition as a group.

Contaminant Group	Contaminant	CAS/ID	WATER TDL ug/L	SOIL TDL ug/Kg
Explosives	2-Amino-4,6-dinitrotoluene (2-Am-DNT)	35572782	1	50
	4-Amino-2,6-dinitrotoluene (4-AM-DNT)	1946510	1	50
	3,5-Dinitroaniline (3,5-DNA)	618871	1	50
	1,3-Dinitrobenzene (1,3-DNB)	99650	1	50
	2,4-Dinitrotoluene (2,4-DNT)	121142	1	50
	2,6-Dinitrotoluene (2,6-DNT)	606202	1	50
	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121824	1	50
	Nitrobenzene (NB)	98953	5	50
	Nitroglycerine (NG)	55630	5	50
	2-Nitrotoluene (2-NT)	88722	5	50
	3-Nitrotoluene (3-NT)	99081	5	50
	4-Nitrotoluene (4-NT)	99990	5	50
	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691410	10	50
	Pentaerythritoltetranitrate (PETN)	78115	5	50
	1,3,5-Trinitrobenzene (1,3,5-TNB)	99354	1	50
	2,4,6-Trinitrophenylmethylnitramine (Tetryl)	479458	1	50
	2,4,6-Trinitrotoluene (2,4,6-TNT)	118967	1	50

TABLE 4. CONTAMINANTS REMOVED FROM TDLs AND DESIGNATED METHODS LIST

Contaminant	CAS/ID
Epifluorohydrin	503093
Epibromohydrin	3132647

Contaminant	CAS/ID
Methane (soils-soil gas))	74828
1,2,3-Trichlorobenzene	87616

TABLE 5. RATIONALE FOR REDUCING TDLs FROM PREVIOUS OPERATIONAL MEMORANDA

WATER				
CONTAMINANT	CAS/ID	New TDL ug/L	Previous TDL ug/L	RATIONALE
Specific Contaminants				
Acetic Acid	64197	[1,000]	18,000	GSI = 360
Formic Acid	64186	1,000	18,000	Formate TDL
Nitrogen Forms				
Ammonia-N	7664417	25	50	CALC GSI = 29
Metals				
Antimony	7440360	2	5	GSI DW = 2
Arsenic	7440382	5	20	DW PROPOSED = 10
Copper	7440508	4	5	CALC GSI = 4.1
Nickel	7440020	20	25	CALC GSI = 24
Vanadium	7440622	4	10	DWC = 4.5
DRO and GRO				
Diesel Range Organics	DRO	100	400	Consistency with previous guidelines for STD
Gasoline Range Organics	GRO	200	400	
Organics, Carbonyls				
Acetaldehyde	75070	100	500	GSI = 130
Dissolved Gases				
Methane	74828	500	500,000	Explosive Criteria = 520
Polynuclear Aromatics				
Benzo(ghi)perylene	191242	[1]	5	WS = 0.26
Benzo(b)fluoranthene	205992	1	2	WS = 1.5
Benzo(k)fluoranthene	207089	[1]	5	WS = 0.8
Benzo(a)pyrene	50328	[1]	2	GCC = 0.64
Chrysene	218019	1	5	WS = 1.6
Fluoranthene	206440	1	5	GSI = 1.6
Phenanthrene	85018	2	5	GSI =2.4
Semivolatiles				
Aniline	62533	4	20	GSI = 4
4-Chloroaniline	106478	10	20	Superfund QL = 10
Dibenzofuran	132649	4	5	GSI = 4
Hexachlorobutadiene (C-46)	87683	0.05	5	GSI = 0.053
1,2,4,5-Tetrachlorobenzene	95943	2	5	GSI = 2.9
Volatiles				
Tetrahydrofuran	109999	90	100	DWC = 95

TABLE 5. RATIONALE FOR REDUCING TDLs FROM PREVIOUS OPERATIONAL MEMORANDA

WATER				
		New TDL	Previous TDL	
CONTAMINANT	CAS/ID	ug/L	ug/L	RATIONALE
Oxygenates				
t-butyl Alcohol	75650	50	800	Monitoring of oxygenates
Acid Herbicides				
Dinoseb	88857	[1]	5	GSI = 0.48
Chlorinated Pesticides				
Endosulfan I	959988	0.03	0.05	GSI = 0.03
Endosulfan II	33213659	0.03	0.05	GSI = 0.03
Polychlorinated biphenyls				
Aroclor 1232	11141165	0.2	0.4	Default to total PCB TDL

TABLE 5. RATIONALE FOR REDUCING TDLs FROM PREVIOUS OPERATIONAL MEMORANDA

SOILS				
		New TDL	Previous TDL	
CONTAMINANT	CAS/ID	ug/kG	ug/kG	RATIONALE
Specific Contaminants				
Acetic Acid	64197	20,000	900,000	DW PC = 41,000
Formic Acid	64186	20,000	900,000	Acetate TDL
Cyanides				
Cyanide, Total	CN_TOTAL	100	200	GSI PC = 104
Cyanide, Available	CN_AVAIL	100	500	GSI PC = 104
Metals				
Antimony	7440360	**[300]**	500	GSI DW = 300
Mercury, Total	7439876	**[50]**	100	GSI = 0.026
Silver	7440224	**[100]**	500	GSI PC = 67
Acid Extractables (Phenols)				
2,4-Dinitrophenol	51285	830	1700	Superfund QL = 830
4-Chloro-3-methylphenol	59507	280	330	DW = 280
2-Methyl-4,6-dinitrophenol	534521	**[830]**	1700	DW PC = 400
3-Nitrophenol	554847	830	1700	Consistency
4-Nitrophenol	100027	830	1700	Superfund QL = 830
Semivolatiles				
Aniline	62533	330	1700	DW PC = 420
4-Chloroaniline	106478	330	1700	Superfund QL = 330
Hexachlorobutadiene (C-46)	87683	50	330	GSI PC = 91
2-Nitroaniline	88744	830	1700	Superfund QL = 830
3-Nitroaniline	9909	830	1700	Superfund QL = 830
4-Nitroaniline	100016	830	1700	Superfund QL = 830
Volatiles				
Benzyl Chloride	100447	150	200	DW PC = 154
1,4-Dioxane	123911	500	1000	DW PC = 680
Oxygenates				
t-butyl Alcohol	75650	2500	4400	Monitoring of oxygenates
Ethyl Alcohol	64175	2500	4400	Monitoring of oxygenates
Chlorinated Pesticides				
alpha-Hexachlorocyclohexane (BHC)	319846	10	20	DW PC = 18
Organophosphorus				
Atrazine	1912249	50	150	DW PC = 60
Cyanazine	21725462	200	500	DW PC = 200

Abbreviations Used in Table 5:

CALC GSI:	Groundwater to surface water interface criterion that is based on a calculation.
Consistency:	TDL was set at a level consistent with other contaminants of this type.
DW:	Drinking water.
DWC:	Drinking water criteria.
DW PC:	Soil protective of drinking water criteria.
GCC:	Groundwater direct contact criteria.
GSI:	Groundwater to surface water interface.
PC:	Protection criteria.
STD:	Storage Tank Division.
Superfund QL:	Quantitation limit established in the U.S. EPA Contract Laboratory Program.
WS:	Water solubility criteria.

TABLE 6. TDLS GREATER THAN THE MOST RESTRICTIVE CRITERIA

CONTAMINANT	CAS/ID	WATER		SOIL	
		TDL ug/L	LOWEST HEALTH BASED CRITERIA ug/L	TDL ug/Kg	LOWEST HEALTH BASED CRITERIA ug/Kg
Specific Contaminants					
Acetic Acid	64197	1,000	360		
Metals					
Beryllium	7440417	1 [1]	0.24		
Mercury, Total	7439976			50	1.2
Silver	7440224	0.2 [1]	0.06	100	27
Polynuclear Aromatics					
Benzo(k)fluoranthene	207089	1	0.8		
Benzo(ghi)perylene	191242	1	0.26		
Benzo(a)pyrene	50328	1	0.64		
Dibenzo(ah)anthracene	53703	2	0.21		
Indeno(1,2,3-cd)pyrene	193395	2	0.022		
Nitrosoamines					
N-Nitrosodi-n-propylamine	621647	5	0.19	330	100
Benzidines					
Benzidine	92875	0.3	0.0037	1000	6
3,3'-Dichlorobenzidine	91941	0.3	0.14	2000	28
Acid Extractables (Phenols)					
4-Chloro-3-methylphenol	59507			330	280
2,6-Dimethylphenol	576261			330	88
3,4-Dimethylphenol	95658			330	200
2-Methyl-4,6-dinitrophenol	534521	20	2.6	830	400
Semivolatiles					
Aniline	62533			330	80
Carbazole	86748	10	3.9		
Hexabromobenzene	87821	10	0.17		
Pentachlorobenzene	608935	5	0.019		
Pyridine	110861	20	7.3		
p-Toluidine	106490			660	300
Volatiles					
Acrylonitrile	107131			100	52
1,2-Dibromo-3-chloropropane	96128			10	4
Epichlorohydrin	106898	5	2		
Ethylene Dibromide	106934			20	1
Tetranitromethane	509148			500	51

TABLE 6. TDLS GREATER THAN THE MOST RESTRICTIVE CRITERIA

CONTAMINANT	CAS/ID	WATER TDL ug/L	WATER LOWEST HEALTH BASED CRITERIA ug/L	SOIL TDL ug/Kg	SOIL LOWEST HEALTH BASED CRITERIA ug/Kg
Carbamates					
Aldicarb Sulfone	1646884			200	40
Aldicarb Sulfoxide	1646873			200	80
Acid Herbicides					
Dinoseb	88857	1	0.48	200	43
Chlorinated Pesticides					
Aldrin	309002	0.01	8.7E-6		
Chlordane	57749	0.05	0.0025		
Chlorpyrifos, ethyl	2921882	0.2	0.002	10	1.5
4,4'-DDT	50293	0.02	0.00001		
Dieldrin	60571	0.02	6.5E-6		
Heptachlor	76448	0.01	0.0018		
Lindane (gamma BHC)	58899			20	0.99
Mirex	2385855	0.02	6.8E-6		
Toxaphene	8001352	1	0.000068		
tris(2,3-Dibromopropyl) phosphate	126727	10	0.71		
Organophosphorus					
Dichlorvos	62737			50	32
Polychlorinated Biphenyls					
Polychlorinated Biphenyls	1336363	0.2	0.000026		
Dioxins & Furans					
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746016	1E-5	3.0E-9		
Asbestos					
Asbestos	1332214			1%	68,000

1. The calculated GSI may be below the TDL in Table 1.

TABLE 7. CONTAINMANTS WITH ESTABLISHED RISK-BASED CRITERIA WITHOUT TDLS AND DESIGNATED ANALYTICAL METHODS

CONTAMINANT	CAS NO
Acrylic acid	79107
Camphene	79925
1-Chloro-1,1-difluoroethane	75683
Diacetone alcohol	123422
Diethylene glycol monobutyl ether	112345
Diisopropylamine	108189
N,N-Dimethylacetamide	127195
N,N-Dimethylaniline	121697
Dimethylformamide	68122
Dimethylsulfoxide	67685
Diquat (soils)	85007
Endothall (soils)	145733
Ethyl Acetate	141786
Ethylene glycol monobutyl ether	111762
1-Formylpiperidine	2591868

CONTAMINANT	CAS NO
Gentian violet	548629
n-Heptane	142825
n-Hexane	110543
2-Methoxyethanol	109864
N-Methyl-morpholine	109024
Oxo-hexyl acetate	88230357
2-Pentene	109682
Phthalic Acid	88993
Phthalic Anhydride	85449
Piperidine	110894
Propionic Acid	79094
Propyl alcohol	71238
Tributylamine	102829
Triethanolamine	102716
2,2,4-Trimethyl-2-pentene	107404

Remediation and Redevelopment Division

Michigan Department of Environmental Quality

October 22, 2004

RRD OPERATIONAL MEMORANDUM NO. 2

SUBJECT: **SAMPLING AND ANALYSIS - ATTACHMENT 4**
SAMPLE PRESERVATION, SAMPLE HANDLING, AND HOLDING TIME SPECIFICATIONS

Key definitions for terms used in this document:

NREPA:	The Natural Resources and Environmental Protection Act, 1994 PA 451, as amended
Part 201:	Part 201, Environmental Remediation, of NREPA
Part 211:	Part 211, Underground Storage Tank Regulations, of NREPA
Part 213:	Part 213, Leaking Underground Storage Tanks, of NREPA
MDEQ:	Michigan Department of Environmental Quality
RRD:	Remediation and Redevelopment Division
U.S. EPA:	United States Environmental Protection Agency
Criteria or criterion:	Includes the cleanup criteria for Part 201 and the Risk-based Screening Levels as defined in Part 213 and R 299.5706a(4)
Facility:	Includes "facility" as defined by Part 201 and "site" as defined by Part 213

PURPOSE

This attachment to RRD Operational Memorandum No. 2 provides sampling handling, preservation, and holding time specifications. This attachment applies to site assessments, site investigation and response activities under Part 201, Part 211, and Part 213.

SAMPLE CONTAINERS AND PRESERVATIVES

Containers and preservatives should be obtained from the laboratory performing the analysis whenever possible. When this is not possible, arrangements must be made with the selected laboratory to ensure the sample containers and preservatives to be used are appropriate. Preservatives must be provided with appropriate identification marks, safety information, instructions for use if necessary, and with expiration dates. The preservatives and expiration dates must be recorded into field logbooks as samples are collected so that each preserved sample is cross referenced with the added preservative(s).

The specific size, types of containers, and associated container codes used by the MDEQ laboratory are identified in Table 1. Preservatives normally used are listed in Table 2. Appropriate containers for each contaminant are specified with their respective bottle codes in Table 3.

Chemical preservatives should be used in their recommended dosages. If a little preservative is good, more is not necessarily better. Preservatives must be replaced at intervals specified by the manufacturer or laboratory and whenever contamination is suspected. Chemical preservatives should not be added to soil samples, except when specified in a sampling protocol, e.g., methanol preservation of soils analyzed for volatile organic compounds. Chemical preservatives should never be added to unknown or untreated liquid wastes and to samples of unknown matrix or source. Violent reactions can occur as acids are added to basic waste or conversely when bases are added to acidic waste. Adding acids to samples containing high cyanide or sulfide levels could result in generation of dangerous quantities of cyanide or sulfide gas.

Sample preservation should be performed immediately upon sample collection or arrangements made with the laboratory to preserve samples within the specified time. For composite samples, when possible, each aliquot used to make the composite should be preserved at the time of collection. When use of an automated sampler prevents preservation of each aliquot, the aliquots should be maintained at about four degrees centigrade (4° C) until composite samples can be preserved.

If a sample reacts vigorously when preservatives are added, discard the sample and obtain a new sample without preservation. Label the sample appropriately to advise the laboratory that it is not preserved; record the behavior of the sample in the field logbook and on chain of custody or sample receipt forms so that it is appropriately communicated to the laboratory.

CONTAMINATION FROM SAMPLE CONTAINERS OR PRESERVATIVES

Documentation must be maintained by the laboratory to uniquely identify the source of the material used to make each preservative. The results of methanol blanks, trip, and field blank samples should be routinely reviewed for evidence of contamination from preservatives or sample containers. In the event preservative and sample containers cannot be ruled out as contamination sources, relevant information must immediately be provided to the laboratory, and suspect supplies not used until their suitability can be established. If the laboratory determines that preservative or sample containers are possible sources of contamination, the laboratory should then inform their clients as appropriate.

HOLDING TIMES

Samples should be processed and/or analyzed as soon as possible after collection. Table 3 specifies the maximum amount of time the sample and any sub-sample generated from the sample can be held. Samples not meeting these specifications must receive a holding time code or other data qualifier. Where more than one holding time is specified, all applicable holding times should be used to validate results. Samples may be held for longer periods only if the laboratory has data on file to show that the specific types of samples under study are stable for longer periods.

Sample collection and delivery to the laboratory must ensure holding times will not be exceeded. Laboratory sample schedules are contingent upon priorities of other samples and unforeseen events such as instrument malfunction. Schedules can change after samples have been delivered to the laboratory. To minimize the impact of schedule changes, it is important to provide instructions to the laboratory, before or during sample receipt at the laboratory, concerning actions to take when a schedule change affects the ability to meet holding times.

Results from samples analyzed past the holding times are not necessarily unusable. When holding times are exceeded, the usability of the data will depend on such factors as the relationship between sample levels and cleanup criteria, the type of decisions to be based on the data, the presence of other data from other samples, and other factors relative to whether the data establishes a reliable representative concentration of the hazardous substance. When holding times are exceeded, results should be interpreted as a minimum concentration.

VOLATILE CONTAMINANTS

Specifications for collecting soil samples using methanol preservation are provided in RRD Operational Memorandum No. 2, Attachment 6. The preservation of samples to be analyzed for volatile contaminants is dependent upon the requirements provided in SW-846, Method 5035A. This method should be consulted for guidance. Table 3 below has the requirements taken from Method 5035A. Future revisions of Method 5035A may alter these requirements.

DE-CHLORINATION

Water samples existing naturally in the environment should not need de-chlorination. De-chlorination procedures may be required for some samples taken from water sources where chlorination is used. De-chlorination is accomplished using the instructions provided in Table 3, footnote number 4, under De-chlorinate. Specific procedures for methods and contaminants may apply and should be used when possible. Applicable contaminants for which de-chlorination procedures may be required are provided below.

Acetonitrile	1,2-Dibromoethane (EDB)
Acrolein	Nitrosamines
Acrylonitrile	Organophosphorus Pesticides
Acrylamide	Phenolics
Benzidines	Polychlorinated biphenyls
Chlorinated Acids/Herbicides	1,2,3-Trichloropropane
Chlorinated Pesticides	Semivolatiles
1,2-Dibromo-3-Chloropropane	Volatiles

ANALYSIS OF GASOLINE OXYGENATES

High temperature purging during analysis of acid preserved samples can cause ethers to degrade which may result in underreporting of some ethers. When a sample is collected and preserved with acid for the analysis of volatiles that include gasoline oxygenate compounds, methyl(tert)butylether, t-Butyl alcohol, Di-isopropyl ether, Ethyl(tert)butylether, Ethyl alcohol, Methyl alcohol, and Tertiaryamylmethylether, the acid-preserved samples should be neutralized prior to analysis. Trisodium phosphate dodecahydrate (TSP) has been determined by the U.S. EPA to be effective and safe for this purpose. Separate samples may be collected specifically for the analysis of oxygenates, and preserved using TSP to adjust the pH to > 11 rather than preserving them with acid.

SAFETY

Be aware of dangers associated with chemical preservatives and their handling. Obtain Material Safety Data Sheets (MSDSs) from the laboratory providing the preservative prior to the sampling event to determine appropriate safety precautions and first aid. MSDSs should accompany personnel in the field. Preservatives must be stored in sealed containers away from other preservatives, and away from environmental and quality control samples. Use safety glasses and appropriate gloves to handle chemicals and properly place them into a closed chamber at the site until proper disposal can be arranged.

APPLICABILITY

Many published methods include specifications for sample containers, preservation, and holding times that may be specific for certain contaminants analyzed using the specific method. Those specifications may be more detailed than the specifications provided in Table 3 or in similar generic tables. When samples are collected for analysis by a method not specifically listed in Table 3, the method-specific requirements for sample containers, preservation, and holding times must be followed.

There are additional sources of holding time and preservation guidance, including the Clean Water Act, the Resource Conservation Recovery Act, the Safe Drinking Water Act, and the U.S. EPA CLP. The guidelines and specifications in this document are applicable to water and soil matrices and for contaminants regulated under Parts 201, 211, and 213. These guidelines and specifications may not be applicable to other matrices or to cleanups conducted under other regulatory programs. When samples are required to meet the criteria of another regulatory agency, the requirements for sample preservation, sample containers, and holding time of that agency should be applied.

Questions concerning this memorandum should be directed to Mr. A. Ralph Curtis, RRD, at 517-373-8389; or email to curtisar@michigan.gov.

The following documents are rescinded with the issuance of this attachment:

- Environmental Response Division Operational Memorandum 16, Sample Preservation, Sample Handling, and Holding Time Guidelines for the Act 307 Program, dated January 4, 1995.
- Storage Tank Division Operational Memorandum 14, Analytical Parameters and Methods, Sample Handling, and Preservation for Petroleum Releases, Table 4, Container, Preservation, and Holding Time Requirements for Common Petroleum Product Sampling and Analysis, dated June 12, 1998.

APPENDED TABLES:
Table 1. Sample Containers and Container Codes
Table 2. Preservatives
Table 3. Specifications for Sample Containers, Preservation, and Holding Times

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This memorandum and its attachments are intended to provide direction and guidance to foster consistent application of Part 201, Part 211, and Part 213 and the associated administrative rules. This document is not intended to convey any rights to any parties or create any duties or responsibilities under the law. This document and matters addressed herein are subject to revision.

Table 1. Sample Containers and Container Codes

Container Code	Size ml	Bottle Type
DO	250	Glass, glass stopper
GN	500	Plastic
GA	500	Plastic
GG	250	Glass, screw cap
GB	500 250	Plastic Plastic
S	250	Plastic
MA	500	Plastic
MAD	500	Plastic
MD	500	Plastic
MN	500	Plastic
OG	250	Glass, wide mouth
VOA	40	Glass Septum vial
ON	1000	Glass, amber
Sealed Vial	Varies	Laboratory Specific

Container Code	Size ml	Bottle Type
BNA	1000	Glass, amber
MS	250	Glass, wide mouth
GS	250	Glass, wide mouth
OS/BNA	250	Glass, wide mouth
VOA	40	Glass, septum vial (soils require MeOH kit)
SCD	NA	Soil coring device [1,2]
MO	250	Glass, wide mouth
OL	250	Glass, wide mouth
HW	250	Glass, wide mouth
MX	250	Glass, wide mouth
OX	250	Glass septum jar
L	500	Fluoropolymer [1,3]
M	250	Glass or HDP[1]
HDP	125	High Density Polyethylene[1]

1. SCD, L, M and HDP are not MDEQ Lab bottle codes.
2. The syringe type coring device, SCD, refers to the samplers listed in Method 5035A, or other validated samplers.
3. Contact the lab regarding availability and cleaning instructions.

Table 2. Preservatives

The following table represents the preservatives normally used for sampling and the approximate amounts to meet a targeted preservation.

Preservative	Concentration	Preservation	Approximate Amount
Sulfuric Acid (H2SO4)	Conc.	pH < 2	5 drops per 250 ml.
Nitric Acid (HNO3)	1:1	pH < 2	5 ml per 250 ml.
Hydrochloric Acid (HCl)	1:1	pH < 2	5 drops per 40 ml.
Sodium Hydroxide (NaOH)	10 N	pH > 9	2 drops per 250 ml.
		pH > 12	10 drops per 250 ml.
Chloroacetic Acid	0.1 N	pH 4-5	Varies with sample
Trisodium phosphate dodecahydrate (TSP)	Powder	pH> 10	Varies with sample
MeOH	Lab Grade	1:1	10 ml per 10 gr soil.
Ascorbic Acid	Powder	Oxidizing Agents	About 0.6 gr per L.
Sodium Arsenite	0.1 N	Oxidizing Agents	5 ml per L.
Zinc Acetate (ZnAc)	2 N	Interferences	10 drops per 250 ml.
Disodium EDTA	2.5 %	Interferences	1 ml per 100 ml.
Ethylenediamine	Powder	Interferences	50 mg per L.

Table 3. Specifications for Sample Containers, Preservation, and Holding Times

Contaminants [2]	Methods [3]	Container Codes [1]		Preservation [4]	
		Soil	Water		
Specific Contaminants					
Acidity	305.1		MN	4° C	1
Alkalinity	310.1		MN	4° C	1
Anions by Ion Chromatography	9056 300.1		MN	Contaminant Specific [6]	
Acetate			MN	4° C	2
Formate			MN	4° C	2
Bromide			MN	None Required	2
Chloride			MN	None Required	2
Fluoride			MN	None Required	2
Nitrate or Nitrite-N			MN	4° C	4
Nitrate and Nitrite-N			MN	pH < 2 H2SO4, 4° C	2
Ortho-Phosphate-P			MN	4° C	4
Sulfate			MN	4° C	2
Bromate			MN	None Required	2
Chlorate			MN	None Required	2
Chlorite			BNA	50 mg Ethylenediamine per L. 4° C	1
Asbestos	100.1		GN	4° C	4
Biochemical Oxygen Demand	405.1		GN	4° C	4
Bromide	320.1	GS	MN	None Required	2
Chemical Oxygen Demand	410		GA	pH < 2 H2SO4, 4° C	2
Chloride	325	GS	MN	None Required	2
Chlorine, Total Residual	330		GN	None Required	
Color	110		GN	4° C	4
Conductance, Specific	9050A	----	MN	4° C	2
Fluoride	340.1	----	MN	None Required	2
Hardness	130.2	----	MA	pH < 2 1:1 HNO3 / H2SO4, 4° C	6
Hydrogen Ion, pH	9040, 9045	GS	MN	None Required	2

Table 3. Specifications for Sample Containers, Preservation, and Holding Times

Contaminants	Methods	Containers		Preservation	
		Soil	Water		
Specific Contaminants					
Iodide	345.1	----	MN	4° C	2
Odor	SM 2150B	----	GN	4° C	2
Total Organic Carbon (TOC)	415.1	----	GA	pH < 2 H2SO4 / HCl/NaHSO4, 4° C	2
Fraction of Organic Carbon	Walkley-Black	GS	GN	4° C	2
Fraction of Organic Matter	D2974	GS	GN	4° C	2
Oxygen, Dissolved, Probe	360.1	----	DO	None Required	
Oxygen, Dissolved, Winkler	360.2	----	DO	Fix on site with DO Kit [10], avoid aeration, store at 10-20° C in dark.	8
Perchlorate	340.1 9058	GS	MN	None Required	2
Petroleum Hydrocarbon Material[8]	1664 9071B	2xOG	2xOG	pH < 2 HCL, 4° C. For dry soils cool to 4° C. For pourable sediments and soils add 2 ml 1:1 HCl per 100g, 4° C	
Phenolics	420.2	----	GG/GP	pH < 2 H2SO4, 4° C	2
Phosphorus, Ortho, Dissolved	365	----	GN(D)	Filter on site immediately, 4° C	4
Phosphorus, Elemental		----	GA	4° C	4
Phosphorus, Total	365.4	----	GA	pH < 2 H2SO4, 4° C	2
Residue, Total	160.3	----	GN	4° C	7
Residue, Filterable (TDS)	160.1	----	GN	4° C	7
Residue, Non-Filterable (TSS)	160.2	----	GN	4° C	7
Residue, Settleable	160.5	----	GN	4° C	4
Residue, Volatile	160.4	----	GN	4° C	7
Silica	370.1	----	GN	4° C	2
Sulfate	375.1	----	MN	4° C	2

Table 3. Specifications for Sample Containers, Preservation, and Holding Times

Contaminants	Methods	Containers		Preservation	
		Soil	Water		
Specific Contaminants					
Sulfide	9030 376.1	GS		See Footnote 11	7
			S	Cover surface of collected soil with 2 M ZnAc until moistened. No headspace.	
Sulfite	377.1	----	HDP	Avoid contact with air, cool < 50° C and add 1 ml EDTA [12] per 100 ml., < 50° C	
Temperature	170.1	----	----	Not Applicable	
Total Recoverable Petroleum Hydrocarbons (TRPH)	8440 [13]	GS	----	4° C	
Turbidity	180.1	----	GN	4° C	48
Biological Tests					
Coliform, Fecal and Total	9131 9132	----	M	4° C	8
Fecal Streptococci	SM 9230	----	M	4° C	6
Cyanides					
Cyanide, Total	9010B	GS	----	See Footnote [15]	14
				Unpreserved	24
Cyanide, Available	OIA1677	GS	GB	See Footnote [15]	14
				Unpreserved	24
Cyanide, Amenable (Free)	D4298-02	----	GB	pH ≥ 12 NaOH, store in dark, 4° C	24
Nitrogen Forms					
Ammonia – N	350.1	GS	GA	pH < 2 H2SO4, 4° C	28
Kjeldahl – N	351.1	GS	GA	pH < 2 H2SO4, 4° C	28
(Nitrate + Nitrite) – N	353.2	GS	GA	pH < 2 H2SO4, 4° C	28
(Nitrate + Nitrite) – N	353.2	GS	GA	4° C	24
Nitrate – N or Nitrite – N	353.2	GS	GN	4° C	48

Table 3. Specifications for Sample Containers, Preservation, and Holding Times

Contaminants	Methods	Containers		Preservation			
		Soil	Water				
Mercury							
Mercury, Total	7470 7471	MS	MA	pH < 2 1:1 HNO3 , 4° C	28		
Mercury, Low Level	1669/1631	MS	L	10 ml 1:1 Hg-free HNO3 per L, 4° C	28		
Hexavalent Chromium							
Chromium VI (waters)	7199	—	HDP	Use buffer solution [16] to adjust pH 9-9.5 (check with pH paper or pH meter) 4° C	24		
	7196	---	MN	4° C	24		
					C Pi		
Chromium VI (soils)	3060A [17]	MS	—	4° C, Store field-moist.			
				Dry Soils:	2		
				High moisture soils and sediments:	30		
Low Molecular Weight Acids	5560 C	GS	GN	None Required			
Glycols	8015C	GS	GN	None Required			
Phosphorus, White [18]	7580	OX	VOA	Limit contact with air. No headspace, 4° C, store in dark. Tightly seal extracts and refrigerate.	5		
				Extracts:			
				Ether Extract			
				Iso-Octane Extract			

Table 3. Specifications for Sample Containers, Preservation, and Holding Times

Contaminants	Methods	Containers		Preservation		
		Soil	Water			
Metals						
Metals, Totals	6010/6020	MS [19]	MA	pH < 2 1:1 HNO3, 4° C	6	
Metals, Dissolved	6010/6020	---	MD MA(D)	Filter and preserve < 24 Hours of sampling. pH < 2 1:1 HNO3 , 4° C	6	
Specific Organic Compounds						
Acetonitrile	8033	---	2 x VOA	pH < 2 H2SO4, 4° C	14	
Acrolein	603 8316	---	2 x VOA	pH 4-5 HCl, 4° C	14	
Acrolein	603	---	2 x VOA	4° C	3	
Acrylonitrile	603	---	2 x VOA	4° C	14	
Acrolein and Acrylonitrile	603	---	2 x VOA	pH 4-5 HCl, 4° C	14	
Acrolein and Acrylonitrile	603	---	2 x VOA	4° C	3	
Acrylamide	8032	---	2 x VOA	pH < 2 HCL/H2SO4, 4° C	14	
Specific Organic Compounds					**Col Pre**	
Benzidines	605 8270C	OS BNA	BNA	Adjust pH 2-7 using H2SO4 and 10 N NaOH. If 1,2-dephenylhydrazine is expected to be present, adjust pH to 3.8-4.2 H2SO4 and 10 N NaOH 4° C, store extracts in inert atmosphere in dark	W	
Carbamates	8318	OS BNA	BNA	Cool, pH 4-5 using 0.1 N Chloroacetic Acid, 4° C, store sample and extracts in dark	W S	
Carbonyls	8315A	OS BNA	BNA	4° C	W S	

Table 3. Specifications for Sample Containers, Preservation, and Holding Times

		Containers				
Contaminants	**Methods**	**Soil**	**Water**	**Preservation**		
Specific Organic Compounds					C P	
Chlorinated Acids/Herbicides	8151A	OS/BNA	BNA	4° C, store samples and extracts in dark	W: S:	
Dioxins and Furans	8290 1613	OS/BNA	ON	4° C, store in the dark		
1,2-Dibromoethane (EDB) 1,2-Dibromo-3-Chloropropane, 1,2,3-Trichloropropane	8011 504.1		VOA	4° C	W:	
Nitrosamines	8270C	OS/BNA	BNA	pH 7-10 with H2SO4 and 10 N NaOH, store extracts in sealed vials, in dark at -10° C	W: S:	
Chlorinated Pesticides [20]	8081A	OS/BNA	2 x ON See 23 [23]	pH 5-9 with H2SO4 and 10 N NaOH within 72 hours, 4°C, store extracts in dark.	W: S:	
Organophosphorus Pesticides [21]	8141A	OS/BNA	ON	4° C Store samples and extracts in dark	W: S:	
Polychlorinated biphenyls	8082	OS/BNA	2 x ON See 23 [23]	4° C Store extracts in dark	W: S:	
Semivolatiles [22]	8270C	OS/BNA	2 x BNA See 23	Store extracts in sealed vials, in dark at -10° C	W: S:	

Table 3. Specifications for Sample Containers, Preservation, and Holding Times

Contaminants	Methods	Containers	Preservation	
Volatiles (waters)				
Fuel Oxygenates	8260B	2 x VOA	no headspace, TSP to pH > 11, 4° C	18
Reactive compounds [24]	8260B	2 x VOA	no headspace, 4° C	
Other Compounds	8260B	2 x VOA	pH < 2 using 1:1 HCl or solid NaHSO4, no headspace, 4° C	14
Volatiles (soils) [25]				
Reactive Compounds Examples include styrene, 2-Chloroethylvinylether	Low Concentration	Sealed Vial	Use reagent water (no acid preservative), freeze > -20° C , < -7° C on site	
		SCD	4° C or freeze > -20° C , < -7° C on site, extruded into sealed vial without acid preservative within 48 hours	
Volatile Compounds	Methanol	2 x VOA	Preserve on site using ratio 1:1 methanol to soil, 4° C	14
Volatile Compounds	Methanol	SCD	4° C or freeze > -20° C , < -7° C on site and extruded into sealed vial with methanol within 48 hours	14

Table 3. Specifications for Sample Containers, Preservation, and Holding Times

Hazardous Waste Characterization Using Method 1312

Contaminants	Containers	Field Collection To TCLP Extraction	TCLP Extraction To Preparative Extraction	Preparative Extraction To Determinative Analysis	
Volatiles	OX	14 Days	Not Applicable	14 Days	2ε
Semivolatiles	MX	14 Days	7 Days	40 Days	6'
Mercury	MX	28 Days	Not Applicable	28 Days	5ε
Metals	MX	180 Days	Not Applicable	180 Days	36

Radiochemistry Contaminants

Radiochemistry Contaminant	Method	Containers Water	Preservation	Co
Gross Alpha, and Gross Beta	9310	1 L HDP or Glass	pH to 2 1 N HNO3	6 Months
Alpha Emitting Radium Isotopes	9315	1 L HDP or Glass	pH to 2 1 N HNO3	6 Months
Radium 228	9320	1 L HDP or Glass	pH to 2 1 N HNO3	6 Months

Unpreserved samples for analysis of radiochemistry contaminants must be received at the laboratory within five days o

Table 3. Specifications for Sample Containers, Preservation, and Holding Times

Wisconsin GRO/DRO Guidelines

Contaminants Organic Compounds	Methods	Containers Soil	Containers Water	Preservation [26]	Collec Prep	
Gasoline Range Organics	8015-Wis					
Waters:			3 x VOA	0.5 ml 1:1 HCl to sample bottle first, no headspace, avoid agitation, 4° C	14 Da	
Carbonate aquifer waters:			3 x VOA	Preserved with Sodium Azide [27]	14 Da	
Carbonate aquifer waters:			3 x VOA	Without Sodum Azide [27]	2 Da	
Soils:		VOA		Preserve in field with MeOH, 4° C	21 Da	
		SCD		4° C, preserve with MeOH < 48 Hours	21 Da	
Diesel Range Organics	8015-Wis					
Waters:			BNA [28]	5 ml 1:1 HCL to sample bottle first, no headspace, 4° C	7 Da	
Carbonate aquifer waters:			BNA [28]	Preserved with Sodium Azide [27]	7 Da	
Carbonate aquifer waters:			BNA [28]	Without Sodium Azide [27]	2 Da	
Soils:		VOA SCD		4° C, preserve with MeOH 1:1 < 72 hours	47 Da	

Table 3. Specifications for Sample Containers, Preservation, and Holding Times

For soils requiring leach tests to evaluate the mobility of non-volatile contaminants in soils [29]

Contaminants[31]	Methods	Containers	Preservations (sample and leachate)		Holdir			
			Sample	Leachate [32]	Collection To Leaching	Leaching To Preparatio		
Mercury	7470	MX	4° C	pH < 2 1:1 HNO3, 4° C	28 Days			
Metals	6010B/6020	MX	4° C	pH < 2 1:1 HNO3, 4° C	180 Days			
Semivolatiles	8270C	MX	4° C	4° C, Store extracts from the leachates in dark at -10 ° C	14 Days	7 Days		
Pesticides	8081A	MX	4° C	pH 5-9 10 N NaOH and H2SO4, 4° C	14 Days	7 Days		
PCBs	8082	MX	4° C	4° C, Store extracts from the leachate in dark	14 Days	7 Days		

For soils requiring leach tests to evaluate the mobility of volatile contaminants in soils

Contaminants	Methods	Containers	Preservations (sample and leachate)		Holdi	
			Sample	Leachates	Collection To Leaching	
Volatiles [33]	8260B	2 x SCD	< 4° C	pH < 2 1:1 HCl, 4° C	48 Hrs	

Table 3 Footnotes

1. The container sizes and types specific for the MDEQ Environmental Laboratory (MDEQ Lab) are listed in this table when applicable. Other laboratories may specify other sizes and types. Letters in parentheses () indicate that the included letter must be added to the prefix code on the bottle from the MDEQ Lab to indicate to the laboratory what process was used, if any, for preservation.
2. "Contaminants" refers to elements, individual compounds, groups of compounds, chemical or physical properties. Contaminant groups in Table 3 are underlined and are simply identified for convenience. These group names do not reflect any official or standardized groups used by other agencies. Italicized contaminant names indicates that the MDEQ Lab does not perform analysis for the contaminant.
3. Methods in the table are listed primarily to clarify the type of method routinely used for environmental samples and preservation used for associated contaminants. The methods listed are not the only methods acceptable. RRD Operational Memorandum No. 2, Attachment 1, TDLs and Available Methods lists the available analytical methods the MDEQ has determined capable of achieving theTDLs. When available methods are used, applicable sample preservation techniques within those methods must be used.
4. Abbreviations and terms used for preservation are as follows:

Abbreviation	Meaning	Abbreviation	Meaning
< - >	Less than - Greater than	HNO3	Nitric acid
M	Molar concentration	NaOH	Sodium hydroxide
N	Normal concentration	ZnAc	Zinc acetate
HCl	Hydrochloric acid	° C	Degrees centigrade
H2SO4	Sulfuric acid	In Situ	Measure in matrix
EDTA	Ethylenediamine,tetra,acetic acid		

ASAP – Make arrangements to deliver samples overnight and have laboratory analyze samples upon receipt.
Immediately - Transport samples to laboratory within 24 hours or overnight. Plans must be made in advance to have the laboratory analyze the samples upon receipt.
4° C – Store samples at about four degrees centigrade. Just above freezing up to six degrees C is acceptable. Ice is preferred to cool samples. If commercial ice packs are used, the bottom, walls, and top inside cover of the cooler must be lined with the packs so as to completely encapsulate the samples as much as possible. A temperature control sample should be included when blue ice packs are used.
De-chlorinate – Means that a portion of the sample should be separated and tested for residual chlorine. Diethyl-p-phenylenediamine (DPD) kits are commercially available to test for residual chlorine in the field. About 25 mg ascorbic acid powder per 40 ml sample, for each 5 mg/L of residual chlorine determined from the DPD kit, should be added to sample bottles testing positive that are to be used to analyze for volatile contaminants, prior to sampling. For non-volatile contaminants use 80 mg/L sodium thiosulfate per liter of sample for each 5 mg/L of residual chlorine found. If pH adjustment is necessary, perform pH adjustment after dechlorination. Do not mix dechlorination reagents with the preservatives used to adjust the pH. Treat the samples only if they contain free or combined chlorine. Most environmental samples are not chlorinated while tap water samples originating from a municipal water source usually are chlorinated.
pH – Indicates an estimated hydrogen ion measurement. Use only the specified chemicals to adjust pH. Do not add more than is needed to obtain the desired pH. If preservation using hydrochloric or sulfuric acids (HCl or H2SO4) is needed, two drops of 1:1 HCl, or H2SO4 for every 40 ml of sample, will lower the pH to less than two for most waters.

Table 3 Footnotes

5. "Holding Time" refers to the maximum time that a sample or sub-sample can be held before the next step in the analysis is performed. Samples may be held for other specified times if the laboratory has supporting data to demonstrate stability. Exceptions to times specified in the heading of this column are explained within the table for each applicable contaminant.
6. The method of preservation and the holding time for samples analyzed by this method are determined by the anions of interest. In a given sample, the anion that requires the most preservation treatment and the shortest holding time will determine the preservation treatment. Note: The addition of EDA has no effect on bromate or chlorate, so they can also be determined in a sample preserved with EDA. Residual chlorine dioxide should be removed from the sample. Any residual chlorine dioxide present in the sample will result in the formation of additional chlorite prior to analysis. If any concentration of chlorine dioxide is suspected in the sample, the sample must be purged with an inert gas (helium, argon, or nitrogen) for approximately five minutes or until no chlorine dioxide remains. This sparging must be conducted prior to ethylenediamine preservation and at time of sample collection.
7. Limit compositing to less than 24 hours and then follow grab sample guideline of 24 hours after collection.
8. Several methods are available to measure TPH. Results are method dependent.
9. No hold time has been established. Samples should be analyzed as soon as possible.
10. The MDEQ Lab DO kit uses solutions designated as DO-1 (Manganese Sulfate) and DO-2 (alkaline Iodide-Azide).
11. Prior to collection, add to sample bottle 8 drops 1 M ZnAc per 100 ml sample to be collected and enough 10 N NaOH expected to make pH > 9. Collect sample with minimum of aeration, add more NaOH as needed to increase pH > 9. Fill bottle without headspace. If the sulfide concentration is expected to exceed 64 mg/L, increase the amount of ZnAc proportionally.
12. Disodium EDTA. Prepare using 2.5 g per 100 ml distilled water.
13. Applicable to mineral oils. Not appropriate for analysis of soils for gasoline and other light petroleum fractions.
14. Under the Federal Safe Drinking Water Act guidance, a 30-hour holding time for coliform samples mailed from water treatment systems is acceptable. Water samples for coliform analysis should have 1-2 inches of headspace in the sample container.
15. Aqueous samples should be tested for sulfides, oxidizing agents, and soluble aldehydes within 15 minutes of sampling to determine and preserve as appropriate. Alternatively, all samples may be preserved with NaOH to a pH>12 and sent to the lab for analysis within 24 hours.

    A. Test for Oxidizing Agents

       Test a drop of the sample with potassium iodide-starch test paper. A blue color indicates the need for treatment.
       To samples testing positive add 0.1N Sodium Arsenite solution a few ml at a time until a drop of sample produces no color on the indicator paper. Add an additional 5 ml of Sodium Arsenite solution for each liter of sample.
       Ascorbic Acid can be used as an alternative although it is not as effective as Sodium Arsenite. Add a few crystals of Ascorbic Acid at a time until a drop of sample produces no color on the indicator paper. Then add an additional 0.6 g of Ascorbic Acid for each liter of sample volume.

Table 3 Footnotes

B. Test for Sulfides (Note that samples are always treated with Lead Carbonate or Cadmium Nitrate.)

Samples with visible particulates must be filtered.
Keep this filter (#1).
Treat samples with solid Lead Carbonate or Cadmium Nitrate powder and immediately filter.
Discard this filter.
Test filtrate for sulfides using Lead Acetate paper and further treat samples showing positive results with Lead Carbonate or Cadmium Nitrate powder and filter.
Discard this filter.
Continue testing until samples show a negative result for sulfides using Lead Acetate paper.

C. Soluble Aldehydes Test

Use a separate solution of the sample to test for aldehydes.
Treat samples showing a positive result with 20 ml of 3.5% Ethylenediamine solution per liter of sample.

D. Preservation

Reconstitute the sample by adding the sediment collected on filter #1 back into the filtrate.
Add NaOH until the sample pH > 12 and cool to 4°C.
Maximum holding time is now 14 days. Equipment blanks must be handled the same as real samples.

16. Buffer Solution. Dissolve 33 g of ammonium sulfate in 75 ml of reagent water and add 6.5 ml of ammonium hydroxide. Dilute to 100 ml with reagent water. Degas the solution with helium gas for 5-10 minutes prior to use. Add the buffer solution, drop wise, to the sample and check after addition with pH paper, or continuously with a pH meter.
17. Method 3060A must be used for preparation of soils. Barium chromate is only partially soluble using Method 3060A. This method may not be appropriate for investigations involving this contaminant when high levels of barium are found at sites.
18. White phosphorus from munitions is released into the environment in the form of small, discrete particles. These particles persist in soils, sediments, and may occur as suspended or colloidal particles in anoxic waters. Therefore, some samples or sample aliquots from a given location may contain P4 particles while others do not. The nature and distribution of P4 contamination from other, non-military, sources has not been studied, but sample collection procedures should address the likelihood that P4 is present in discrete particles, and must be designed to ensure that multiple representative samples of the matrix of interest are collected. In addition, soil and sediment samples must be carefully homogenized and sub-sampled.

    Aqueous samples should be poured gently into the sample container to minimize agitation which might drive off the volatile P4. If bubbling does occur while transferring the sample to the container, the sample should be discarded and another sample collected. Each container should be filled with sample until it overflows. Each container should be tightly sealed with a PTFE-lined cap. The container should then be inverted to check for air bubbles. If any air bubbles are present, a new sample must be collected.

Table 3 Footnotes

19. If boron is a chemical of concern at a site, use a wide mouth plastic container for collection of soil samples.
20. If analysis includes BHCs, cis, trans-Permethrin, or Trifluralin, samples should be extracted as soon as is practical. See requirements for specific pesticides, published under the Safe Drinking Water Act and applicable to drinking water samples.
21. If analysis includes Disulfoton Sulfoxide, Diazinon, Pronamide, or Terbufos, samples must be extracted as soon as is practical.
22. Includes groups referred to in other guidance as:
    Total Petroleum Hydrocarbons (TPH), Acid Extractables (Phenols), Chlorinated Hydrocarbons, Nitroaromatics and Isophorone, Nitrosoamines except Diphenylnitrosamine, Polynuclear Aromatics, Phthalate Esters, Haloethers, and Phenolics.
23. If samples are to be analyzed for semivolatiles and pesticides/PCBs, collect a total of three containers. For quality control purposes, collect an additional container for each contaminant group, for every 20 samples.
24. Reactive contaminants with cleanup criteria include 2-chloroethylvinyl ether and styrene. Contact the laboratory regarding other contaminants.
25. Preservation as provided in RRD Operational Memorandum No. 2, Attachment 6 is required for the collection of soils. The MDEQ Lab provides a sampling kit to collect soil samples using this procedure. Soils collected to determine volatiles leached from soils should be sampled with 25 gr syringe-type coring devices.

    The sonication time used to extract the volatile compounds from the soil is important and must be standardized for analysis of volatile organic compounds in soil and comparison of results with the cleanup criteria. Soils should be sonicated as soon as possible after receipt, and a 20-minute sonication time must be used as specified in the MDEQ Lab SOP #501, Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS).

26. Specifications must be followed from Modified DRO, Method for Determining Diesel Range Organics, Wisconsin DNR, September 1995 for DRO and Modified GRO, Method for Determining Gasoline Range Organics, Wisconsin DNR, September 1995, for GRO.
27. The pH of all water samples must be determined by the laboratory unless sample vials containing acid for field preservation were supplied by the lab. The pH measurement may be performed on left-over sample. If the pH is greater than two, the sample results must be flagged. Flagging is not required of samples collected from carbonate aquifers if preserved with sodium azide or extracted within 48 hours of collection.
28. The Wisconsin procedure requires a Teflon™ lined cap. The Teflon™ must be touching the sample.
29. The data in this table applies to soils to determine potential leaching of contaminants. See RRD Operational Memorandum No.2, Attachment 2, Soil Leaching Methods for applicable leaching tests.

    Each soil type tested should have associated quality control as provided in the leaching procedures. This requires spiking the leaching solution with the contaminants of concern at levels above the TDLs listed in RRD Operational Memorandum No.2, Attachment 1. When relevant pathways have been evaluated for response activity under Part 201 or Part 213, spiking the leaching solution may be appropriate at approximately one-half of the cleanup criteria for the appropriate pathway whenever possible. Duplicate samples should be collected to facilitate the spiking of samples.

Table 3 Footnotes

The crushing, cutting, grinding, sieving, and filtering, or other procedures used in leaching procedures may alter the physical characteristics of soils. As the physical characteristics of soils may affect the mobility of contaminants, such procedures are not appropriate for soils for the purposes of this test. Such procedures may be appropriate for other types of material such as brick and concrete.

Samples collected and stored using a syringe-type coring device (SCD), as specified in Method 5035 of SW-846, should be extruded directly into the leaching solution by the laboratory to minimize exposure to the atmosphere.

After completion of the leaching procedure for soils, aliquots taken for analysis of specific contaminants must be immediately collected and preserved as specified in Table 3 for aqueous solutions of the respective contaminants.

30. Other holding times, specific for compounds within the contaminant groups, may be more appropriate. If the compounds of concern at a site have been established, use specifications in this table specific for these compounds, or specifications as may be provided in the analytical method itself.
31. Contact the MDEQ Lab concerning the use of leaching procedures for other contaminants.
32. Extracts from leaching tests should be preserved immediately after leaching, according to the guidance given in the individual analysis methods for the contaminants being measured.
33. Sample collection procedures using a syringe-type coring device, as provided in Method 5035, are appropriate when leaching is used to evaluate the mobility of volatile components leached from soils. Extrusion of the soil sample into the leaching solution by the laboratory is required within 48 hours. After completion of the leaching procedure, an aliquot of leaching solution must be immediately collected and preserved as specified in Table 3 for associated contaminants in aqueous solutions. If larger sample sizes are required, multiple devices must be used.

DEQ

Remediation and Redevelopment Division

Michigan Department of Environmental Quality

October 22, 2004

RRD OPERATIONAL MEMORANDUM NO. 2

SUBJECT: SAMPLING AND ANALYSIS - ATTACHMENT 5
COLLECTION OF SAMPLES FOR COMPARISON TO GENERIC CRITERIA

Key definitions for terms used in this document:

NREPA:	The Natural Resources and Environmental Protection Act, 1994 PA 451, as amended
Part 201:	Part 201, Environmental Remediation, of NREPA
Part 211:	Part 211, Underground Storage Tank Regulations, of NREPA
Part 213:	Part 213, Leaking Underground Storage Tanks, of NREPA
MDEQ:	Michigan Department of Environmental Quality
RRD:	Remediation and Redevelopment Division
U.S. EPA:	United States Environmental Protection Agency
Criteria or criterion:	Includes the cleanup criteria for Part 201 and the Risk-based Screening Levels as defined in Part 213 and R 299.5706a(4)
Facility:	Includes "facility" as defined by Part 201 and "site" as defined by Part 213
Low Flow:	Minimal drawdown groundwater sampling procedures as described in the United States Environmental Protection Agency, Office of Research and Development, Office of Solid Waste and Emergency Response, EPA/540/S-95/504, December, 1995, EPA Groundwater Issue
Response Actions:	Includes "response activities" as defined by Part 201 and "corrective action" as defined by Part 213

PURPOSE

This attachment to RRD Operational Memorandum No. 2 provides direction for collection of groundwater and soil samples for comparison to generic criteria for site assessment, site investigation, and response actions under Part 201, Part 211, and Part 213.

Generic cleanup criteria for groundwater and soil have been developed pursuant to Sections 20120a(1) and 21304a of NREPA (see RRD Operational Memorandum No. 1). These criteria are the risk-based values the department has determined to be protective of the public health, safety, or welfare and the environment. The evaluation of sampling data to establish compliance with cleanup criteria under the provisions of Part 201, Part 211, and Part 213 requires data that reliably establish a representative concentration of the hazardous substance in a given environmental medium. The representativeness of the data can be maximized by using proven accurate and reproducible techniques and verified by using appropriate quality assurance and control procedures in the field and laboratory. This operational memorandum designates sampling, analysis, and quality assurance and control protocols for consistent data collection to facilitate gathering the information necessary for the department to determine compliance with the applicable provisions of Part 201, Part 211, or Part 213. Additional guidance regarding sampling strategies and methodology is available in RRD Operational Memorandum No. 4.

CALIBRATION OF FIELD EQUIPMENT

Instruments and equipment used to gather, generate, or measure environmental data should be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications. Equipment used for field sampling should be examined to certify that it is in operating condition. This includes checking the manufacturing's operating manual and the instructions for each instrument to ensure that all maintenance requirements are being observed. Calibration of field instruments should be performed in accordance with the manufacturer's recommendations and guidelines and at the intervals specified by the manufacturer or more frequently as conditions dictate. At a minimum, equipment should be calibrated prior to each sampling event. In the event that an internally calibrated field instrument fails to meet calibration/checkout procedures, it should not be used in the field until it is serviced and calibrated.

COLLECTION OF SOIL SAMPLES FOR COMPARISON TO THE GENERIC CRITERIA

<u>General Considerations</u>

The soil and groundwater terminology used for this discussion include the following:

- Unsaturated/Vadose Zone: a subsurface zone above the capillary fringe in which the soil pores are only partially filled with water. The moisture content is less than the porosity.
- Saturated Zone: contains two components
  - Capillary Fringe: a subsurface zone above the water table in which the soil pores are filled with water and the pressure heads are less than atmospheric.
  - Water Table: the water level surface below the ground at which a well screened in an unconfined aquifer would fill with water.
- Smear Zone: the vertical area over which groundwater fluctuates (thereby the contaminated water will smear floating and dissolved contamination into the soils in the zone).

Soil samples must be representative of the soils located in the area affected by the release of hazardous substances. The exposure assumptions for soil pathways are based on dry soil. For comparison to the applicable generic soil criteria soil samples must be collected from the vadose zone. The results must be reported by the laboratory on a dry weight basis (adjusted for the vadose zone soil moisture content). Soil analytical methods cannot be applied to saturated soils because they do not provide representative results.

Neither soil nor water sample analyses methods are appropriate for comparison of saturated "soils" samples to generic soil or groundwater cleanup criteria. The cleanup criteria are based upon exposure assumptions appropriate only for soil or water, individually, and are not applicable to exposure to saturated "soil" as a mixture of soil and water.

Contaminants present in the unsaturated soil zone shall be evaluated by comparison of soil sample analyses to the applicable soil criteria. If contaminants are present in a saturated soil zone a monitoring well should be properly installed and the groundwater sampled. These groundwater sample results shall be compared to the applicable groundwater criteria. If free product is suspected and/or a smear zone exists near the water table, a monitoring well shall be appropriately installed so that the water table is bisected by the well screen. Additional guidance regarding monitor well construction is available in RRD Operational Memorandum No. 4.

While analysis of saturated "soil" samples cannot be used to demonstrate compliance with generic cleanup criteria, laboratory analyses or field instrument readings of saturated soils may be of qualitative value for remedial evaluation and design purposes. For example indications of high concentrations in saturated soils may indicate a need to prevent construction worker exposure to shallow saturated soils. This information may also assist in determining the nature of the contaminant and in treatment evaluations. If such data are included as part of response actions under Part 201 or Part 213 rationale for the use must be provided.

If the water surface elevation drops significantly from the time that the original soil investigation was performed, samples should be collected from any former "smear zone" prior to site closure.

Evaluating Exposure Due To Lead In Soil

The amount of lead in soil has historically been evaluated by analyzing lead concentrations in the total soil sample. However, recent evidence indicates that the fine soil fraction, defined as less than 250 microns in size, is more appropriate for comparison to soil direct contact criteria (DCC) and particulate inhalation criteria (PSIC). Exposure to lead in ingested soil and dust is best represented by the lead concentration in the particle size fraction that sticks to hands or that is most likely to accumulate in the indoor environment as a result of wind-blown soil deposition and transport of soil on clothes, shoes, pets, toys and other objects. Additionally, exposure to lead in inhaled soil and dust is best represented by the lead concentration in the particle size fraction likely to enter the respiratory system and become lodged in the alveoli. The particle size fraction of soil and dust likely to be ingested or inhaled is the fine soil fraction. Generally the fine fraction has the higher concentration of lead, but it is possible that the coarse fraction may contain more lead. Therefore, when collecting soils for facility evaluation, both fine and coarse fraction analyses are necessary to determine lead exposure. MDEQ Laboratory SOP #213 provides appropriate procedures for sample preparation. To assure protectiveness, the concentration of lead in each fraction must be compared to the direct contact criteria separately. Only the concentration of lead in the fine fraction must be compared to particulate soil inhalation criteria. The concentration the total lead concentration must be compared to other lead soil criteria. For response actions under Part 201 and Part 213, if the direct contact and particulate inhalation pathways have been appropriately documented to be "not relevant" it is not necessary to analyze the fractions separately.

COLLECTION OF GROUNDWATER SAMPLES FOR COMPARISON TO THE GENERIC CRITERIA

General Considerations

Groundwater samples collected for analyses must be representative of the water moving in the aquifer, in the contaminant plume or in the target zone where contaminants are expected to be located or to migrate. Groundwater samples must represent the contaminant concentrations, including dissolved and naturally suspended particles. Stagnant water in monitor well casings is not representative of the groundwater. Purging of the stagnant water in monitor well casings is necessary but must minimize changes in groundwater chemistry to yield water samples that are representative of the groundwater. Indicator parameters including temperature, pH, dissolved oxygen, specific conductivity and turbidity must be monitored during the purging process to determine stabilization between the well casing waters and the formation waters. Turbidity is the most conservative indicator of stabilization as it is often the last to stabilize. Turbidity in groundwater samples may be naturally occurring, caused by the contamination, or a result of sampling disturbances such as accidental inclusion of aquifer matrix materials from disturbances or mixing that may occur while sampling. Knowledge of site geology, well design, and sampling methodology is helpful in determining the source of turbidity and the method of sampling. Turbidity due to sampling disturbances should be eliminated or minimized while naturally occurring turbidity or turbidity due to contamination should not.

A sampling methodology must be used that accounts for the effects of aquifer heterogeneities while minimizing alterations in water chemistry that could result from sampling disturbances. The MDEQ will accept properly conducted purging methods designed to minimize drawdown by controlling the flow from the well while monitoring stabilization indicator parameters, commonly referred to as Low-Flow methods. Available Low-Flow procedures include United States Environmental Protection Agency, Office of Research and Development, Office of Solid Waste and Emergency Response, EPA/540/S-95/504, December 1995, EPA Ground Water Issue, *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*, Robert Puls and Michael Barcelona (http://www.solinst.com/Text/restext/407txt.html) and *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells*, United States Environmental Protection Agency Region 1, July 30, 1996, Revision 2 (http://www.epa.gov/region01/measure/well/wellmon.html). If another sampling methodology is used, documentation must be submitted to the MDEQ with the data that demonstrates why it is as representative of aquifer conditions as low-flow methodologies. Careful use of the Low-Flow methods is essential in collection of groundwater samples from wells that contain non-aqueous phase liquids, as these substances may be stratified in the monitoring well. Where non-aqueous phase liquid is present, refer to additional guidance for sampling strategies for non-aqueous phase liquids available in RRD Operational Memorandum No. 4, Attachment 5.

Collection of Inorganic Groundwater Samples

Traditionally, the standard practice for collecting metals samples from monitoring wells to evaluate the drinking water pathway had prescribed that samples be filtered with a 0.45 micron filter before inorganic analysis. The practice minimizes the potential for artificially elevated particulate loading resulting in overestimation of metal concentrations. However, U.S. EPA has determined that contaminant concentrations and the potential human health risk may be drastically underestimated for filtered samples (*Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells*, U.S. EPA Region 1, July 30, 1996, Rev 2). Use of the Low-Flow sampling methodologies minimizes sampling disturbances, improves the data quality, and is the method recommended by the MDEQ.

Inorganic constituents must be measured as totals (i.e., unfiltered with appropriate preservation) unless groundwater samples cannot be collected without adequately minimizing the influence of sampling disturbances, in which case filtering may be necessary prior to preservation. The intent of the field-filtration is only to eliminate or minimize sampling disturbances or interference. Any necessary filtration should be accomplished using a filter with a large enough pore size to allow naturally suspended particles to pass through the filter. Some preliminary testing may be required to determine the appropriate filter size. Site-specific conditions may require that both a filtered and unfiltered sample be collected to adequately evaluate the contaminant concentrations. Documentation for the use of filtration and the evaluation of appropriate filter sizes must be provided to the MDEQ with the data.

Collection of Organic Groundwater Samples

Samples to be analyzed for organic substances should not be filtered regardless of sample turbidity except as described in the next paragraph. When response action under Part 201 or Part 213 requires evaluation of the dermal contact with groundwater for contaminants listed in R 299.5750 footnote (AA) an additional set of groundwater samples should be collected for organic substances analysis which should be filtered for analysis of the dissolved phase. The groundwater contact criteria equation estimates the dermal adsorption of hazardous substances that are in the dissolved phase. Therefore, when analyzing for contaminants that strongly adsorb to soil particles, those samples should be filtered so that contaminants in the dissolved phase can be estimated. Filters of appropriate material should be used to ensure the filter does not absorb dissolved contaminants that are not attached to particulates. Glass filters with no binders are acceptable and recommended. Some preliminary testing may be required to determine the appropriate filter medium and pore size. Documentation of the evaluation of appropriate filter medium and size must be provided to the MDEQ with the data.

GENERAL QUALITY ASSURANCE AND QUALITY CONTROL

In order to insure that representative data is used to evaluate facilities, quality assurance and quality control (QA/QC) procedures must be implemented to assure that the precision, accuracy, and representativeness of the data are known and documented. This includes appropriate sample distribution to evaluate the extent of contamination; appropriate sample collection, preservation, shipping, and analysis methodology; collection and analysis of collocated, replicate and split duplicate samples for evaluation of precision; and collection and analysis of field, equipment, and trip blanks as well as matrix spike, matrix spike/duplicate, and laboratory spike samples for analysis of accuracy. Sample distribution and collection are more completely discussed in Operational Memorandum No. 4. Sample handling, preservation, and holding times are discussed in Attachment 4 of this Operational Memorandum. Collection of duplicate, blank and spike samples is discussed below.

Collection of Duplicate Samples to Evaluate Precision

Precision estimates the reproducibility of measurements under a given set of conditions and is reflected in the field duplicate samples and laboratory duplicates analysis. Overall precision for a sampling set is a mixture of field sampling techniques and laboratory techniques. Three types of duplicate samples are relevant to this document: collocated, replicates, and split samples. Collocated samples should be collected and used to estimate the overall precision of a data collection activity. Sampling error can be estimated by inclusion of both collocated and replicated versions of the same samples. Definitions of these samples are listed below:

- Collocated samples are independent samples collected at the same location and at the same time and, for the purpose of these site assessments, processed and analyzed by the same laboratory. Collocated samples are not mixed together and then split into two or more samples. They are two separate samples from an identical site location. They provide a good estimate of precision information for the entire system, including transportation, sampling technique, homogeneity of the site, and laboratory analysis. Examples of collocated samples are samples taken from a moving stream, side by side soil core samples (nesting), two air quality samples taken from one common sample manifold, and two water samples taken from essentially the same point in a lake or lagoon. Collocated samples are used to estimate the overall precision of a data collection activity. Sampling error can be estimated by including a replicate sample with a collocated sample.

- Replicate samples are samples that have been divided into two or more portions at the same step in the measurement process. Examples of replicate samples include two samples taken from a single purged well, samples collected in a common container and then put into separate containers or a soil sample which is thoroughly mixed in a tray and divided into separate containers. Replicate samples are processed and analyzed by the same laboratory.
- Split samples are replicate samples divided into two portions, sent to different laboratories, and subjected to the same environmental conditions and steps in measurement process. They serve as an oversight function in assessing the analytical portion of a measurement system. Samples are often split between the MDEQ and a facility owner or liable party.

<u>Collection of Blank and Spike Samples to Evaluate Accuracy</u>

Accuracy estimates the bias in a measurement system. Accuracy is difficult to estimate for the entire data collection activity. Sources of error include: sampling procedure; field contamination; preservation handling; sample matrix; sample preparation; and analytical techniques. Sampling accuracy can be audited through field, equipment, and trip blanks, while analytical (or laboratory) accuracy can be audited through spike samples and the surrogate recovery results.

A field blank is prepared by pouring distilled/deionized water directly into sample containers. This preparation is performed in the area where sample handling and preservation operations occur. The field blank sample is handled and shipped in the same manner as other analytical samples. Field blank sample analytical results are used to evaluate sample handling, preservation, and shipping procedures.

An equipment blank can be prepared by pouring distilled/deionized water through or over a piece of sampling equipment and collecting rinsate in a sample container. Results of equipment blank analysis are used to evaluate field decontamination procedures and to determine the likelihood of cross contamination.

A trip blank, which normally applies only to volatiles, is a sample that is prepared before any sampling is performed. This sample is shipped from the warehouse to the field and then to the laboratory. Results of trip blank analysis are used to evaluate possible contamination of containers/samples from the time the sample containers are prepared through the field event to the time the samples are received and analyzed at the laboratory.

Laboratory blanks are used to estimate variabilities caused by technique, in-house contamination, and other laboratory problems. Laboratory blanks are prepared by the laboratory.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples and surrogates are samples that are spiked in the laboratory. MS/MSD samples for organic and inorganic water analyses require an extra sample volume. The actual MS/MSD sample is prepared by the laboratory to evaluate accuracy.

Field background, or upgradient samples may need to be collected on a site-specific basis and should be collected from a clean location and shipped with other samples from the site. These samples should be submitted to the laboratory as routine field samples and should not be defined as blanks.

To provide adequate QA/QC for site investigations, the following duplicate, blank and matrix spike samples should be taken. Duplicate and field blank samples should be taken at critical sampling locations, but not at the same location from which the matrix spike/duplicate sample is obtained. They should be sent to the laboratory as blind samples. Reduced QA/QC evaluations may be implemented on a case by case basis with approval of the MDEQ RRD Project Manager.

	Duplicate Samples[1]				Blank Samples		
QA/QC Sample Type	**Collocated**	**Replicate**	**Split**	**MS/MSD**	**Field**	**Equipment**	**Trip**
Recommended Number of QA/QC Samples	1 per 10 or fewer samples per matrix[2] and analytical group[3], at least 1 per day	When used: 1 per matrix and analytical group per day	When used: 1 per 1 for samples that will be split	1 per 20 or fewer samples per matrix and analytical group, at least 1 per day	1 per 20 or fewer samples per matrix and analytical group, at least 1 per day	1 per 10 or fewer samples per matrix and analytical group, at least 1 per day	1 per every volatile organic sample shipping container
QA/QC Sample Collection	Individual samples taken from the same location not mixed together and then split.	One sample divided into two or more portions then analyzed by the same laboratory	Replicate samples sent to different labs for analysis	Water samples require double volumes. Samples should be taken at critical locations but different from the field blank.	Fill the sample containers with deionized or distilled water in the area where sample handling and preserving operations occur. Handle and ship the field blank sample as other samples.	Pour deionized or distilled water over or through the sampling equipment and collect rinsate in the sample container. Handle and ship the field blank sample as other samples.	Fill the sample container with deionized water. This in prepared before any sampling is performed and travels to the field and the laboratory with the other sample containers.

[1] Normally no field duplicate is required for samples of waste containers or other high concentration samples.

[2] soil, groundwater, surface water, sediment, or drinking water, etc.

[3] volatile organics, semi-volatiles. pesticides/PCBs, metals, cyanide, etc.

Note: Where method 8260+ volatile analysis for soils, sediments, sludges, and waste container samples is done, methanol blank samples should be collected by the laboratory for each methanol lot used. These lots should be tracked in the field and reported on the laboratory receipt form so laboratory correlations can be made.

SAMPLE CHAIN OF CUSTODY

An essential part of any sampling and analytical scheme is ensuring the integrity of the sample from collection to data reporting. The possession and handling of samples should be traceable from the time of collection through analysis and final disposition. This documentation, referred to as chain of custody, is particularly necessary if there is any possibility that the analytical data or conclusions based upon analytical data will be used in litigation. Regardless of the potential for litigation, these procedures are useful for routine control of sample flow.

A sample is under your custody if it is in your possession; is in your view, after being in your possession; was in your possession and you placed them in a secured location; or is in a designated secure area.

As few people as possible should handle the samples. The field sampler/sampling crew should track the chain of custody in the field on the individual sample data collection sheets and chain of custody tracking reports before shipment. Samples should be collected following the appropriate sampling procedures and documented on the sample data sheet. The equipment used to collect samples should be noted, along with the time of sampling, sample location, type and description, depth at which the sample was collected, and any other pertinent remarks. All bottles and jars should be properly labeled with sample number, date and time of collection, and location. Sample labels and tags should be affixed to the each sample container prior to or at the time of sampling. Sample seals should be used to detect any unauthorized tampering with samples from the time of sample collection to the time of analysis.

A record should be kept of data-collecting activities performed. A field logbook is a useful tool for keeping such records. Entries into the logbook may contain a variety of information such as site contacts, phone numbers, assigned laboratories, addresses, etc. Documentation of on site weather conditions and activities that take place during sampling events should be described in as much detail as possible so that persons going to the site can re-construct a particular situation without reliance on memory. The record for each sampling event should include the date, start time, names of all persons present, level of personal protection being used, and the signature of the person recording the information. Measurements made and samples collected should be recorded. All entries in field logbooks should be made in ink and no erasures made. If an incorrect entry is made, the information should be crossed out with a single strike mark. When a sample is collected, or a measurement is made, a detailed description of the location of sample collection (such as a map point which includes compass and distance measurements or Global Positioning System location information) should be recorded. Equipment used to make measurements should be identified, along with the date of calibration.

A chain of custody record should be filled out and should accompany every sample container shipped or delivered to the laboratory. This record becomes especially important if the sample data could be introduced as evidence in litigation. For each sample in the container, the chain of custody record should include the sample number, signature of the collector, date and time of collection, place and address of collection, sample matrix, and signature and inclusive dates of possession for each person involved in the chain of possession from the point of sample collection through sample analysis.

The following document is rescinded with the issuance of this attachment:

- Storage Tank Division Informational Memorandum 16, Policy regarding the appropriate use of saturated soil sampling results under the Leaking Underground Storage Tank (LUST) Program, dated October 21, 1998.

This memorandum and its attachments are intended to provide direction and guidance to foster consistent application of Part 201, Part 211, and Part 213 and the associated administrative rules. This document is not intended to convey any rights to any parties or create any duties or responsibilities under the law. This document and matters addressed herein are subject to revision.

Remediation and Redevelopment Division

Michigan Department of Environmental Quality

October 22, 2004

RRD OPERATIONAL MEMORANDUM NO. 2

SUBJECT: **SAMPLING AND ANALYSIS – ATTACHMENT 6**
SAMPLING METHODS FOR VOLATILE ORGANIC COMPOUNDS

Key definitions for terms used in this document:

NREPA:	The Natural Resources and Environmental Protection Act, 1994 PA 451, as amended
Part 201:	Part 201, Environmental Remediation, of NREPA
Part 211:	Part 211, Underground Storage Tank Regulations, of NREPA
Part 213:	Part 213, Leaking Underground Storage Tanks, of NREPA
MDEQ:	Michigan Department of Environmental Quality
RRD:	Remediation and Redevelopment Division
U.S. EPA:	United States Environmental Protection Agency
Contact time:	The time from when the sample was preserved with methanol to the time the aliquot was taken for analysis, or the time the sample was in contact with the methanol prior to analysis.
Criteria or criterion:	Includes the cleanup criteria for Part 201 and the Risk-based Screening Levels as defined in Part 213 and R 299.5706a(4)
Facility:	Includes "facility" as defined by Part 201 and "site" as defined by Part 213
Method 5035A:	U.S.EPA Method 5035, "Closed-System Purge-and-Trap and Extraction for Volatiles Organics in Soil and Waste Samples," Test Method for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, USEPA, Office of Solid Waste and Emergency Response, Dec 1996, Third Edition.
Method 5021A:	U.S.EPA Method 5021A, "Volatile Organic Compounds in Various Sample Matrices Using Equilibrium Headspace Analysis", Test Method for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, U.S.EPA, Office of Solid Waste and Emergency Response, Dec 1996, Third Edition.
Response Actions:	Includes "response activities" as defined by Part 201 and "corrective action" as defined by Part 213
Sonication:	The procedure for mixing the soil with methanol using sound waves.

PURPOSE

This attachment to RRD Operational Memorandum No. 2 provides direction for the collection and preservation of soil samples using the procedures in U.S.EPA Methods 5035A and 5021A for analysis to determine concentrations volatile organic compounds (VOCs). This attachment is applicable for site assessments, site investigations, and response activities under Part 201, Part 211, and Part 213.

To produce reliable representative analytical results, the MDEQ implemented the use of the methanol preservation procedures for the preservation of soil samples collected for analysis to determine concentrations of VOCs on April 30, 1998.

INTRODUCTION

The requirements for collection and preservation of samples are based on the latest revisions of U.S. EPA Methods 5035A and 5021A. The applicable contaminants that can be measured are listed within the methods. Other contaminants may be included if method performance data exists for the contaminant that demonstrates the accuracy, precision and detection that can be measured.

Guidance on applicable target detection limits (TDLs) and available analytical methods are included in RRD Operational Memorandum No. 2, Attachment 1.

USE OF PROCEDURES WITHIN METHODS 5035A and 5021A

Method 5035A includes several procedures for the collection and preparation of soils for VOCs analysis. These include high concentration methods (methanol preservation), sealed samplers using soil coring devices, and the low concentration soil method using sealed containers for direct attachment to the analytical instrument. Method 5021A provides for the sample preparation of both waters and soils using sealed containers.

<u>Method 5035A, High Concentration Method – Option 1, Methanol Preservation</u>

The MDEQ accepts results generated using the high concentration soil method of Method 5035A for site assessment, site investigations, and response activities, provided the requirements listed below are followed and documented:

- Samples are preserved with methanol in the field using a procedure consistent with that provided in this document.
- At least ten grams of soil are collected.
- The ratio of methanol volume to soil weight is equal to or greater than one.
- Samples are sonicated for at least 20 minutes as soon as possible upon receipt at the lab.
- An aliquot of methanol is taken immediately after sonication, and stored for analysis.
- The sample with methanol is not used for analysis of volatiles once the aliquot of methanol is taken.
- The laboratory standard operating procedures provide the information listed within this document's section entitled Laboratory Related Procedures and Documentation.
- Operational Memorandum No. 2, Attachment 1, Target Detection Limits and Available Methods direction has been followed.

<u>Method 5035A, High Concentration Method – Option 2, Bulk Sampling</u>

The bulk sampling procedure in Method 5035A does not produce a reliable representative sample because it is susceptible to volatilization and biodegradation. Therefore, the MDEQ does not accept results generated using bulk sampling procedures, unless acceptable justification is provided that documents the nature of the sample prevents sampling by the procedures described as acceptable in this document.

Method 5035A, Low Concentration Method

The MDEQ accepts results generated using the low concentration soil method of Method 5035A, for site assessment, site investigations, and response activities, provided the requirements listed below are followed and documented:

- The sealed containers are attached directly to the instrumentation.
- The preservation is applied correctly to the various soil types.
- Information that validates the use of the method with the appropriate type of soil is provided.
- Information that demonstrates the effectiveness of the sealed containers ability to prevent the exposure of the sample to environmental conditions is provided.

The low concentration preservation procedure may not be appropriate for all soil types. For example, calcareous soils cannot be sampled by the low concentration method when sodium bisulfate is used because a chemical reaction occurs that adversely affects the results. Soil samples must be tested in the field prior to collecting the samples for analyses, as discussed in Method 5035A, to determine if the acidic preservation for the low concentration procedure can be used. If the acidic preservation cannot be used, alternate procedures for preservation in Method 5035A should be used. The preferable alternate procedure is to extrude the samples into empty sealed vials and freeze on site to < -7 C°. Care must be taken to not freeze the vials below -20 C° to avoid potential problems with vial seals.

Method 5021A, Headspace Analysis using Sealed Containers

The MDEQ accepts results generated using the sample collection and preservation methods of Method 5021A for site assessment, site investigations, and response activities, provided the same requirements for Method 5035A, Low Concentration Method are documented. The preferred analytical method is Method 8260B (see RRD Operational Memorandum No. 2, Attachment 1). This sample and collection procedure is highly recommended for the analyses of contaminants that are very soluble in water.

Method 5035A, Soil Coring Devices (used to transfer samples to the laboratory)

The MDEQ requires the use of soil coring devices to evaluate the leaching of volatiles from soils, as provided in Operational Memorandum No. 2, Attachment 2, Soil Leaching Methods. The requirements in Attachment 2 must be met.

The MDEQ does not recommend the use of soil coring devices for initial site characterization where the objectives include establishing the contaminants of concern; or for response activities where the objectives are to demonstrate final compliance with cleanup criteria. The MDEQ may accept results using the soil coring devices, providing the following requirements are documented:

- Scientific studies exist that demonstrate the device to be effective for the use intended. The manufacturer of the device should be contacted regarding studies that prove them effective.
- The party proposing the use of the soil coring devices must demonstrate the effectiveness of the devices to retain volatile chemicals, for the specific chemicals of concern at the facility. Demonstration of the effectiveness of the devices proposed to be used can be accomplished using duplicate sampling. The demonstration must include duplicate samples

collected using methanol preservation in the field. Duplicate samples must be collected for a minimum of one sample, or for at least one of every five samples collected.
- Written protocols must be established regarding the use of the devices to collect samples, and to preserve samples at the laboratory. These protocols must be provided to the MDEQ.
- Confirmation samples must be collected using methanol preservation in the field, equivalent to the standard operating procedure of this document. Confirmation samples must be collected for a minimum of two samples, or for at least two from every ten samples collected.
- All requirements of Method 5035A regarding the use of the samplers must have been met.

OXYGENATES

Oxygenates refer to methyl(tert)butylether (MTBE), t-Butyl alcohol (TBA), Di-isopropyl ether (DIPE), Ethyl(tert)butylether (ETBE), Ethyl alcohol, Methyl alcohol, and Tertiaryamylmethylether (TAME), and the oxygenated ethers refer to MTBE, DIPE, ETBE and TAME. When any of the oxygenated ethers are required for analysis, and high temperature purging is used in the analysis, samples collected must have the pH adjusted to > 10 in the field using Trisodium phosphate dodecahydrate (TSP), or two samples can be collected and the laboratory instructed to neutralize one prior to the analysis for oxygenated ethers. The laboratory should be contacted regarding its procedure for the analysis of oxygenated ethers to determine if high temperature purging is used. Methods 5035A and 5021A can be used for sampling for oxygenates, provided the requirements in this document are met. Method 5021A is highly recommended.

Questions concerning this document should be directed to Mr. A. Ralph Curtis, Toxicology Unit, RRD, at 517-373-8389, or email to curtisar@michigan.gov.

The following documents are rescinded with the issuance of this attachment:

- Environmental Response Division procedure for the Collection and Methanol Preservation of Soils for Volatile Organics, dated May 1, 2000.

- Storage Tank Division procedure for the Collection and Preservation of Soil Samples for Volatile Organic Analysis, dated May 18, 2000.

- Storage Tank Division Informational Memo No. 13 "Implementation of Environmental Protection Agency (EPA) SW-846 Method 5035 Closed-System Purge and Trap and Extraction for Volatile Organics in Soils and Waste Samples", dated September 4, 1998.

APPENDAGE:

Standard Operating Procedure for Methanol Preservation in the Field

This memorandum and its attachments are intended to provide direction and guidance to foster consistent application of Part 201, Part 211, and Part 213 and the associated administrative rules. This document is not intended to convey any rights to any parties or create any duties or responsibilities under the law. This document and matters addressed herein are subject to revision.

STANDARD OPERATING PROCEDURE for METHANOL PRESERVATION IN THE FIELD

SUMMARY

Soil samples are collected using conventional procedures, including auger and split spoon techniques. Sub-samples are then taken using syringe-type coring devices and immediately transferred into pre-weighed VOC vials containing reagent grade methanol sufficient to obtain an estimated ratio of 1:1 with the soil. The samples are transferred to the laboratory. Upon receipt at the laboratory, the following steps are taken as soon as is practical:

An accurate sample weight is determined.
The sample container is swirled gently to break up soil clumps.
The sample is sonicated for 20 minutes.
An aliquot taken and stored for analyses using Method 8260B.

Method 5035A uses a 2:1 ratio of methanol volume to soil weight. This ratio is acceptable contingent that the requirements in Operational Memorandum No. 2, Attachment 1, Target Detection Limits and Available Methods, are met.

LABORATORY RELATED PROCEDURES AND DOCUMENTATION

Procedures - The laboratory selected should have written standard operating procedures that address the provision of sampling supplies intended for methanol preservation of samples, sample receipt checks, sample preparation steps and documentation, sample collection requirements, and analyses. The laboratory should first be contacted regarding specific requirements. The laboratory's standard operating procedure governing the sample preparation should specify the contact time routinely applied, and when this time period is not met, this must be narrated with the results. The following documentation must be included:

- Copies of the certifications of the methanol used.
- Percent moisture in the samples (determined using separate vial/container with just soil).
- Dates samples were collected, and preserved if not immediately performed upon collection.
- Dates samples were received at the laboratory.
- Sample weights.
- Sample moisture (soils and sediments).
- Actual ratios of methanol to soil.
- Sonication dates/times.
- Minutes of sonications if different from 20 minutes.
- Dates/times aliquots were taken for analysis, if not taken immediately after sonification.
- The dates of the analysis.

MDEQ LABORATORY SPECIFICATIONS FOR SAMPLE COLLECTION

The following specifications apply for sample collection kit provided by the MDEQ laboratory. Other laboratories may have similar kits with specifications. Contact the laboratory selected.

Target Soil Weight = 10 grams
Allowed Weight = 9 to11 grams
Size of VOC Sampling Vials = 40 ml

Methanol Volume (provided in tubes) = 10 ml
Soil Coring Device (Syringe Sampler) Size = 10 ml
Green Sticker to Warn of Hazardous Waste
Wide Mouth Jars (4 oz. and 8 oz.)

HEALTH AND SAFETY

Material Safety and Data Sheets (MSDSs) providing health and safety data, and emergency procedures should accompany staff in the field. Methanol ampoules, tubes, and vials must be provided to field staff inside protective containers to hold any spillage. Methanol is a toxic and flammable liquid. Handle with proper safety precautions. Wear safety glasses and protective gloves. Nitrile Rubber or Viton gloves are recommended. Avoid inhalation. Store and handle in a ventilated area, away from sources of ignition and extreme heat. Store methanol in a cool place, preferably in sample coolers on ice. This is especially important for methanol in tubes, where pressure buildup due to extreme heat may result in rupture. Vials should be opened and closed quickly during collection. In the event of eye contact, immediately flush with large amounts of water for at least 15 minutes, occasionally lifting upper and lower lids. Seek medical attention immediately.

SHIPPING

The shipping of methanol is regulated by the U.S. Department of Transportation (DOT), Title 49 of the Code of Federal Regulations. The DOT number is UN 1230. The amount of methanol used for sample preservation falls under the exemption for small quantities. Requirements for shipment of samples by common carrier are as follows:

Maximum volume of methanol in a sample container cannot exceed 30 ml.
The sample container cannot be full of methanol.
Sufficient absorbent material must be used in the container to completely absorb sample content.
Each cooler must have less than 500 ml of methanol.
The cooler or package weight must not exceed 64 pounds.
Each cooler must be identified as containing less than 500 ml methanol.

APPARATUS AND MATERIALS NEEDED FOR SAMPLE COLLECTION

Absorbent Material – If the samples are to be shipped by common carrier, vermiculite or similar material, sufficient to completely absorb the methanol for each sample.

Calibration Weight - Near or equal to the target sample weight.

Certified Methanol – Methanol certified for purge and trap gas chromatography is analytically verified prior to sampling (by lot). In this procedure the methanol is provided in sealed ampoules. Some labs may provide methanol in the sampling vial.

Field Balance - Capable of holding sampling vial and syringe on the wide mouth jar used to prevent balance contamination, and measurement within + 0.2 grams.

Hazardous Waste Warning Label - Suitable vial labels to warn personnel of the presence of methanol as a preservative.

Methanol Sampling Kit/Method 5035A Sampling Kit:

Protective Wear - Nitrile rubber or Viton gloves. Splash proof safety goggles.

Plastic Bags - Air tight seals, capable of holding three sample VOC vials, and sub-coring device.

Protocol to be used for the collection of samples.

Sub-Coring Device - A syringe type device, whose material has been tested and found free of contaminants,. This device is used to sub-sample the targeted amount of soil, for transfer into methanol in the field.

Wide Mouth Jar (for holding methanol tubes) - Of suitable size to allow temporary storage and shipment of the methanol tubes.

Wide Mouth Jar (for preventing balance contamination) - Of suitable size to allow temporary storage of the syringe type sampler and VOC sample vial on the field balance.

Volatile Organic Compound (VOC) Syringe Labels - Methanol resistant labels.

VOC Vials - Vials with Teflon™ lined septa, pre-weighed, with methanol resistant labels.

SAMPLE CONTAINERS, PRESERVATION AND HOLDING TIMES

Containers - Sample containers are VOC Vials with Teflon™ lined septa of suitable size to hold the soil plus methanol, supplied with methanol resistant labels.

Preservation – Samples are preserved in the field approximately one to one ratio of soil weight to methanol volume, using pre-weighed vials and a field balance. The exact sample weights and ratios are determined at the laboratory. More methanol is added to make the ratio one to one when possible. When weights are less than the specified minimum, the reporting limit is increased. The maximum and minimum limits for the weights of soils specified by the MDEQ laboratory are provided in the section of this document entitled "Specifications for the Collection of Samples Using Methanol Preservation."

Holding Times - The maximum allowable holding time is 14 days from sample collection to analysis. If the maximum allowable holding time is exceeded, interpret the results as minimum concentrations of the measured compounds.

QUALITY CONTROL

<u>Field Blanks</u>

Use - Field blanks are used to determine sample contamination that may occur during the storage, transportation, sampling, and analysis of samples. A field blank is a sample vial containing a pre-measured quantity of VOC-free methanol, obtained from the laboratory or prepared in a contaminant free environment.

Frequency - The number of field blanks depends upon project objectives and the field activities being performed at specific locations. It is recommended that a field blank be created at each location where activities may result in significant VOCs released into the environment, or for every 20 samples, whichever is more.

Interpretation – Positive results may indicate contamination from the methanol, the sample container, from the air at the site, from diffusion of air containing volatiles into the blank during transport to the laboratory, or from the laboratory environment. Compare field blank results with trip blank results and laboratory method blanks to isolate the cause. Sample results that approach the field blank results may be unusable.

Trip Blanks

Use - Methanol trip blanks are used to determine if contamination is occurring from the methanol, storage, transportation, or the field.

Frequency - One trip blank should be used per cooler.

Interpretation – Positive trip blanks can be attributed to the methanol, sample vial material, and the environment in the cooler or sample transport container. Trip blanks should be prepared at, and provided by, the laboratory in order to make this interpretation. If consistent positive results are obtained, contact the laboratory and have a trip blank prepared at the laboratory and immediately analyzed to attempt isolation of the cause.

Methanol

Only purge and trap grade methanol verified to be suitable for methanol preservation should be used. Field staff should maintain documentation of the methanol lot numbers for all associated samples. If consistently high levels of compounds are measured in methanol field blanks associated with a specific lot number, request the laboratory to verify the quality of the methanol lot used to preserve the samples.

Contamination

Contamination by airborne VOCs in the air is possible by diffusion through the vial septum during shipment, storage, collection, and analysis. To control such contamination:

Use appropriate VOC sample vials.
Avoid sources that generate VOCs such as petroleum products, especially auto exhaust fumes.
Keep sample containers in coolers as much as possible.
Collect samples quickly.
Use methanol provided in sealed ampoules, tubes, or VOC vials.

Attempt to isolate the source of contamination and incorporate appropriate procedures to avoid similar circumstances.

FIELD BALANCE CALIBRATION CHECK

The field balance calibration should be checked prior to each sampling event, and whenever necessary because of handling in the field. Record this check in the field notebook.

CORRECTIONS FOR SAMPLES WITH HIGH WATER CONTENT

Concentrations of volatile compounds in soils must be reported on a dry weight basis, using the moisture content of the soil to adjust results. Routine procedures by the laboratories include this correction. Laboratories may not routinely correct results because of the effects due to the miscibility of the methanol with the water in the sample. The effects are to bias the results low, and if the moistures in the samples are high, these biases may be significant. The effects of

APPENDIX D

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Appendix D

USEPA Low Stress [low flow] Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUND WATER SAMPLES FROM MONITORING WELLS

July 30, 1996
Revision 2

**U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I**

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUND WATER SAMPLES FROM MONITORING WELLS

I. SCOPE & APPLICATION

This standard operating procedure (SOP) provides a general framework for collecting ground water samples that are indicative of mobile organic and inorganic loads at ambient flow conditions (both the dissolved fraction and the fraction associated with mobile particulates). The SOP emphasizes the need to minimize stress by low water-level drawdowns, and low pumping rates (usually less than 1 liter/min) in order to collect samples with minimal alterations to water chemistry. This SOP is aimed primarily at sampling monitoring wells that can accept a submersible pump and have a screen, or open interval length of 10 feet or less (this is the most common situation). However, this procedure is flexible and can be used in a variety of well construction and ground-water yield situations. Samples thus obtained are suitable for analyses of ground water contaminants (volatile and semi-volatile organic analytes, pesticides, PCBs, metals and other inorganics), or other naturally occurring analytes.

This procedure does not address the collection of samples from wells containing light or dense non-aqueous phase liquids (LNAPLs and DNAPLs). For this the reader may wish to check: Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation; C.K. Smoley (CRC Press), Boca Raton, Florida and U.S. Environmental Protection Agency, 1992, RCRA Ground-Water Monitoring: Draft Technical Guidance; Washington, DC (EPA/530-R-93-001).

The screen, or open interval of the monitoring well should be optimally located (both laterally and vertically) to intercept existing contaminant plume(s) or along flowpaths of potential contaminant releases. It is presumed that the analytes of interest move (or potentially move) primarily through the more permeable zones within the screen, or open interval.

Proper well construction and development cannot be overemphasized, since the use of installation techniques that are appropriate to the hydrogeologic setting often prevents "problem well" situations from occurring. It is also recommended that as part of development or redevelopment the well should be tested to determine the appropriate pumping rate to obtain stabilization of field indicator parameters with minimal drawdown in shortest amount of time. With this information field crews can then conduct purging and sampling in a more expeditious manner.

The mid-point of the saturated screen length (which should not exceed 10 feet) is used by convention as the location of the pump intake. However, significant chemical or permeability contrast(s) within the screen may require additional field work to determine the optimum vertical location(s) for the intake, and appropriate pumping rate(s) for purging and sampling more localized target zone(s). Primary flow zones (high(er) permealability and/or high(er) chemical concentrations) should be identified in wells with screen lengths longer than 10 feet, or in wells with open boreholes in bedrock. Targeting these zones for water sampling will help insure that the low stress procedure will not underestimate contaminant concentrations. The Sampling and Analysis Plan must provide clear instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the remaining criteria in this procedure are met. If after 4 hours of purging indicator field parameters have not stabilized, one of 3 optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization) c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may not meet the sampling objectives).

Changes to this SOP should be proposed and discussed when the site Sampling and Analysis Plan is submitted for approval. Subsequent requests for modifications of an approved plan must include adequate technical justification for proposed changes. All changes and modifications must be approved before implementation in field.

II. EQUIPMENT

A. Extraction device

Adjustable rate, submersible pumps are preferred (for example, centrifugal or bladder pump constructed of stainless steel or

Teflon).

Adjustable rate, peristaltic pumps (suction) may be used with caution. Note that EPA guidance states: "Suction pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" (EPA/540/P-87/001, 1987, page 8.5-11).

The use of inertial pumps is discouraged. These devices frequently cause greater disturbance during purging and sampling and are less easily controlled than the pumps listed above. This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

B. Tubing

Teflon or Teflon lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for inorganics analyses. However, these materials should be used with caution when sampling for organics. If these materials are used, the equipment blank (which includes the tubing) data must show that these materials do not add contaminants to the sample.

Stainless steel tubing may be used when sampling for VOCs, SVOCs, pesticides, and PCBs. However, it should be used with caution when sampling for metals.

The use of 1/4 inch or 3/8 inch (inner diameter) tubing is preferred. This will help ensure the tubing remains liquid filled when operating at very low pumping rates.

Pharmaceutical grade (Pharmed) tubing should be used for the section around the rotor head of a peristaltic pump, to minimize gaseous diffusion.

C. Water level measuring device(s), capable of measuring to 0.01 foot accuracy (electronic "tape", pressure transducer). Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level "tape" at the start and end of each record.

D. Flow measurement supplies (e.g., graduated cylinder and stop watch).

E. Interface probe, if needed.

F. Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate the samples.

G. Indicator field parameter monitoring instruments - pH, Eh, dissolved oxygen (DO), turbidity, specific conductance, and temperature. Use of a flow-through-cell is required when measuring all listed parameters, except turbidity. Standards to perform field calibration of instruments. Analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846. For Eh measurements, follow manufacturer's instructions.

H. Decontamination supplies (for example, non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.).

I. Logbook(s), and other forms (for example, well purging forms).

J. Sample Bottles.

K. Sample preservation supplies (as required by the analytical methods).

L. Sample tags or labels.

M. Well construction data, location map, field data from last sampling event.

N. Well keys.

O. Site specific Sample and Analysis Plan/Quality Assurance Project Plan.

P. PID or FID instrument (if appropriate) to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

III. PRELIMINARY SITE ACTIVITIES

Check well for security damage or evidence of tampering, record pertinent observations.

Lay out sheet of clean polyethylene for monitoring and sampling equipment.

Remove well cap and immediately measure VOCs at the rim of the well with a PID or FID instrument and record the reading in the field logbook.

If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook.

A synoptic water level measurement round should be performed (in the shortest possible time) before any purging and sampling activities begin. It is recommended that water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) be measured the day before, in order to allow for re-settlement of any particulates in the water column. If measurement of total well depth is not made the day before, it should not be measured until after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe are usually not needed unless analytical data or field head space information signal a worsening situation. Note: procedures for collection of LNAPL and DNAPL samples are not addressed in this SOP.

IV. PURGING AND SAMPLING PROCEDURE

Sampling wells in order of increasing chemical concentrations (known or anticipated) is preferred.

1. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the midpoint of the zone to be sampled. The Sampling and Analysis Plan should specify the sampling depth, or provide criteria for selection of intake depth for each well (see Section I). If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well. Collection of turbid free water samples may be especially difficult if there is two feet or less of standing water in the well.

2. Measure Water Level

Before starting pump, measure water level. If recording pressure transducer is used-initialize starting condition.

3. Purge Well

3a. Initial Low Stress Sampling Event

Start the pump at its lowest speed setting and slowly increase the speed until discharge occurs. Check water level. Adjust pump speed until there is little or no water level drawdown (less than 0.3 feet). If the minimal drawdown that can be achieved exceeds 0.3 feet but remains stable, continue purging until indicator field parameters stabilize.

Monitor and record water level and pumping rate every three to five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump (for example, 0.1 - 0.4 l/min) to ensure stabilization of indicator parameters. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. Do not allow the water level to fall to the intake level (if the static water level is above the well screen, avoid lowering the water level into the screen). The final purge volume must be greater than the stabilized drawdown volume plus the extraction tubing volume.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (bladder, peristaltic), and/or the use of dedicated equipment. If the recharge rate of the well is lower than extraction rate capabilities of currently manufactured pumps and the well is essentially dewatered during purging, then the well should be sampled as soon as the water level has recovered sufficiently to collect the appropriate volume needed for all anticipated samples (ideally the intake should not be moved during this recovery period). Samples may then be collected even though the indicator field parameters have not stabilized.

3b. Subsequent Low Stress Sampling Events

After synoptic water level measurement round, check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). Perform purging operations as above.

4. Monitor Indicator Field Parameters

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, Eh, DO) every three to five minutes (or less frequently, if appropriate). Note: during the early phase of purging emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken at three (3) to five (5) minute intervals, are within the following limits:

turbidity (10% for values greater than 1 NTU),
DO (10%),
specific conductance (3%),
temperature (3%),
pH (± 0.1 unit),
ORP/Eh (± 10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell and may also cause an underestimation of turbidity values measured after the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities.

The flow-through-cell must be designed in a way that prevents air bubble entrapment in the cell. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must be submerged in water at all times. If two flow-through-cells are used in series, the one containing the dissolved oxygen probe should come first (this parameter is most susceptible to error if air leaks into the system).

5. Collect Water Samples

Water samples for laboratory analyses must be collected before water has passed through the flow-through-cell (use a by-pass assembly or disconnect cell to obtain sample).

VOC samples should be collected first and directly into pre-preserved sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

During purging and sampling, the tubing should remain filled with water so as to minimize possible changes in water chemistry upon contact with the atmosphere. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use one of the following procedures to collect samples: (1) add clamp, connector (Teflon or stainless steel) or valve to constrict sampling end of tubing; (2) insert small diameter Teflon tubing into water filled portion of pump tubing allowing the end to protrude beyond the end of the pump tubing, collect sample from small diameter tubing; (3) collect non-VOC samples first, then increase flow rate slightly until the water completely fills the tubing, collect sample and record new drawdown, flow rate and new indicator field parameter values.

Add preservative, as required by analytical methods, to samples immediately after they are collected if the sample containers are not pre-preserved. Check analytical methods (e.g. EPA SW-846, water supply, etc.) for additional information on preservation. Check pH for all samples requiring pH adjustment to assure proper pH value. For VOC samples, this will require that a test sample be collected during purging to determine the amount of preservative that needs to be added to the sample containers prior to sampling.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter is required, and the filter size (0.45 um is commonly used) should be based on the sampling objective. Pre-rinse the filter with approximately 25 - 50 ml of ground water prior to sample collection. Preserve filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in ground water for human health risk calculations.

Label each sample as collected. Samples requiring cooling (volatile organics, cyanide, etc.) will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

6. Post Sampling Activities

If recording pressure transducer is used, remeasure water level with tape.

After collection of the samples, the pump tubing may either be dedicated to the well for resampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth is optional after the initial low stress sampling event. However, it is recommended if the well has a "silting" problem or if confirmation of well identity is needed.

Secure the well.

V. DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well and following sampling of each subsequent well. Pumps will not be removed between purging and sampling operations. The pump and tubing (including support cable and electrical wires which are in contact with the well) will be decontaminated by one of the procedures listed below.

Procedure 1

The decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump or the pump can be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and isopropyl alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Flush with isopropyl alcohol (pesticide grade). If equipment blank data from the previous sampling event show that the level of contaminants is insignificant, then this step may be skipped.

Flush with distilled/deionized water. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

VI. FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the ground water samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples shall be collected for each batch of samples (a batch may not exceed 20 samples). Trip blanks are required for the VOC samples at a frequency of one set per VOC sample cooler.

Field duplicate.

Matrix spike.

Matrix spike duplicate.

Equipment blank.

Trip blank (VOCs).

Temperature blank (one per sample cooler).

Equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank will only include the pump in subsequent sampling rounds.

Collect samples in order from wells with lowest contaminant concentration to highest concentration. Collect equipment blanks after sampling from contaminated wells and not after background wells.

Field duplicates are collected to determine precision of sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

If split samples are to be collected, collect split for each analyte group in consecutive order (VOC original, VOC split, etc.). Split sample should be as identical as possible to original sample.

All monitoring instrumentation shall be operated in accordance with EPA analytical methods and manufacturer's operating instructions. EPA analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846 with exception of Eh, for which the manufacturer's instructions are to be followed. Instruments shall be calibrated at the beginning of each day. If a measurement falls outside the calibration range, the instrument should be re-calibrated so that all measurements fall within the calibration range. At the end of each day, check calibration to verify that instruments remained in calibration. Temperature measuring equipment, thermometers and thermistors, need not be calibrated to the above frequency. They should be checked for accuracy prior to field use according to EPA Methods and the manufacturer's instructions.

VII. FIELD LOGBOOK

A field log shall be kept to document all ground water field monitoring activities (see attached example matrix), and record all of the following:

Well identification.

Well depth, and measurement technique.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, and clock time, at the appropriate time intervals; calculated or measured total volume pumped.

Well sampling sequence and time of each sample collection.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analysis.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling equipment used, including trade names, model number, diameters, material composition, etc.

VIII. DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, and whatever field logbook information is needed to allow for a full evaluation of data useability.

EXAMPLE (Minimum Requirements) Page____of____

Well PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Location (Site/Facility Name)________________________________ Depth to ________/________ of screen
Well Number____________________ Date____________________ (below MP) top bottom
Field Personnel________________________________ Pump Intake at (ft. below MP)________________
Sampling Organization________________________________ Purging Device; (pump type)________________
Identify MP________________________________

Clock Time 24 HR	Water Depth below MP ft	Pump Dial[1]	Purge Rate ml/min	Cum. Volume Purged liters	Temp. °C	Spec. Cond.[2] µS/cm	pH	ORP/ Eh[3] mv	DO mg/L	Turb-idity NTU	Comments

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. µSiemens per cm(same as µmhos/cm)at 25 °C.
3. Oxidation reduction potential (stand in for Eh).